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The Mining Magazine

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EDITORIAL

THE 1959 issue of Skinner's Mining Year Book was published earlier this month. This valuable reference work, now in its 73rd consecutive year, contains the latest particulars of 950 companies operating in all parts of the world and also the names and addresses of 1,225 mining engineers, managers and others, and the companies with which they are connected. All the other usual features are included.

UNTIL early in May there was considerable speculation as to the outcome of the talks arranged in New York by the United Nations to discuss the present depressed lead and zinc industry. The conference, it was thought, might attempt to frame a formula acceptable to base-metal producers the whole world over, although how a scheme likely to appeal to producers outside America could possibly be welcomed by United States interests it was difficult to see. The likelihood of a new metal control scheme, this time for lead and zinc, could therefore, it was thought, be discounted, although some general policy on the part of producers is obviously needed. The truth is, of course, that national policies conflict in this instance, as in so many others, with what may be desirable internationally. Free trade remains an ideal at present unlikely of implementation in a world of nations too much on the defensive. In the event it appears that through a series of voluntary undertakings, and providing that consumption remains at the current level, the excess supply of new lead is likely to be reduced to some 59,000 tons annually and that of zinc to 16,000 tons. The conference also recognized that the effect of such voluntary reductions was likely to be of little avail if other producers increased outputs or if Government agencies made untimely disposals of strategic stocks. Further, it was also recognized that the stimulation of increased consumption must be the endeavour of the industry. A real control programme is thus as far away as ever; perhaps it is as well!

Uranium and Thorium in the Commonwealth

A lecture last month on "The Uranium and Thorium Resources of the Commonwealth" delivered by Mr. S. H. U. Bowie, of the Geological Survey's Atomic Energy Division, to the Royal Society of Arts was in itself a special occasion. So much information on uranium is forthcoming these days that it is becoming difficult to realize the extent of the secrecy that has been in force since atomic energy first became an important issue in world affairs. In the event Mr. Bowie, in a brief review of the geology and mineralogy of some of the more important deposits of radioactive minerals and a rapid survey of output data and estimated reserves, gave a breath-taking indication of the vast potential of the British Commonwealth as a producer of the raw materials of atomic energy. In two short tables, reproduced here, reserves of uranium and thorium in the non-Communist countries are impressively summarized, some uranium production figures also being given.

PRODUCTION AND RESERVES OF URANIUM

Country.	*Production, tons U_3O_8, 1958.*	*Reserves, tons U_3O_8.*
Canada	13,537	413,000
Union of South Africa	6,245	330,000
U.S.A.	12,560	221,000
France	815	50,000
Australia	700	15,000
Belgian Congo	1,000	10,000

No reliable data are available on the production of thorium, but a total of 700 tons ThO_2, said Mr. Bowie, is believed to have been produced by non-Communist countries in 1958.

RESERVES OF THORIUM

Country.	*Reserves, tons ThO_2.*
India	300,000
Canada	210,000
Brazil	200,000
Australia	50,000
U.S.A.	50,000
South Africa	15,000
West Africa	15,000
Nyasaland	10,000

Thorium is at present mainly used, it was pointed out, in the production of magnesium-thorium alloys and in the manufacture of thorium nitrate for gas mantles. Some is

being used in experimental reactors but as yet there is no great demand for thorium as a fuel element.

From the figures given the reserves in Canada, mainly in the Blind River field, are shown to be of major importance. Mr. Bowie said that many more areas rich in uranium undoubtedly exist but it was doubtful whether there are many more as large and as rich as Blind River or from which uranium can be produced as a by-product of some other metal, as in the Witwatersrand Basin. In addition to those two major fields the Copperbelt of Northern Rhodesia, however, probably offered most hope as a future large-scale supplier of uranium, while the Blind River field and the placer deposits of India would produce the bulk of the world's thorium.

Nickel Outlook

In the view of Dr. J. F. Thompson, chairman of the International Nickel Company of Canada, world demand for nickel in the current year is expected to be higher than in 1958. Speaking at the annual meeting held in Toronto last month, Dr. Thompson suggested that although nickel consumption in 1958 was considerably lower than production capacity consumers of nickel should be assured of plentiful supplies if the full market potential of the metal was to be realized. Production should be capable of meeting surges in demand that would arise during the anticipated upward trend in nickel consumption, for the company was actively continuing its exploration in Canada and throughout the world for still further sources of the metal.

Referring to the Manitoba project the chairman said that underground development and construction of surface and town facilities at Thompson, Manitoba, were proceeding on schedule, while exploration of the ore-bodies had revealed that the Thompson mine would be capable of meeting the planned objective of 75,000,000 lb. of nickel annually. That had made it advisable to postpone work at the nearby Moak mine and concentrate on the rapid development at Thompson. In Manitoba, since active development work had been under way, the company had expended more than $60,000,000 and, in addition, advanced $20,000,000 to the Manitoba Hydro-Electric Board to assist in financing the development of power facilities in the area. Expenditures by the company for the Manitoba project for the balance of 1959 were estimated at over $30,000,000.

Dr. Thompson had other news to impart. He revealed that it had been decided to construct an electrolytic refinery at Thompson with a capacity of up to 75,000,000 lb. of nickel per year. The refining process to be employed had been developed by research scientists and engineers of the company and its suitability had been demonstrated by commercial operation since December, 1956, in a section of the nickel refinery at Port Colborne. A main feature of the process was the direct electrolysis of nickel matte, which eliminated high-temperature oxidation and reduction operations. He also announced that the usage of natural gas instead of oil as a fuel in the multi-hearth concentrate roasters in the Copper Cliff, Ontario, smelter had been started, another step in the substitution of natural gas for oil in a number of the company's metallurgical operations at Copper Cliff. Finally, commenting on the outlook, Dr. Thompson suggested that contributing factors to expected improved earnings were a sharp surge in demand for nickel in the United States, higher prices for copper, and increased sales of platinum metals.

Institution of Mining and Metallurgy

This year the annual dinner of the Institution of Mining and Metallurgy was held on May 5 in Grocers' Hall, Princes Street, an excellent gathering of members and their guests turning out for the occasion. Following the loyal toasts, Mr. P. F. Barrett, Deputy High Commissioner for the Federation of Rhodesia and Nyasaland, proposed the toast of the Institution, speaking respectfully of the important part the mining companies were playing in the development of the area. The work being done, particularly in Northern Rhodesia, was setting a pattern for those planning the interracial society which would inhabit the Federation, a society whose growth was of such importance to African growth. In reply Mr. J. B. Dennison, the president, said the Institution was fully aware of mining's part in Commonwealth development, particularly as its associate and branch institutions overseas became more active. Indeed, he said, the Council had now set up a special committee to deal with such overseas activities, which were expected to expand. The toast of the guests, proposed by Dr. J. H. Watson, president-elect, elicited an interesting reply from Mr. Dirkse-van-

Schalkwyk, Minister for the Union of South Africa.

In the course of his brief survey of Institution affairs Mr. Dennison referred to the annual awards and his announcement that the Gold Medal was this year to go to Dr. A. J. Orenstein, in recognition of his services in the cause of the health and welfare of mine workers, particularly in South Africa, was well received. The other recipients are Mr. F. A. Williams, who is to have the Consolidated Gold Fields of South Africa, Ltd., Gold Medal for his paper on the treatment of the decomposed granites of the Jos Plateau, and Mr. H. H. Fraser and Mr. O. E. A. Somerset, who receive the same company's premium for their paper on "Scientific Management Principles Applied to West African Mining." The "William Frecheville" Student's Prize goes to Mr. I. R. M. Chaston for his paper entitled "A Simple Formula for Calculating the Approximate Capacity of a Hydrocyclone." Honorary Memberships are conferred on Mr. W. A. C. Newman, Brigadier R. S. G. Stokes, and Sir Alexander Fleck, all of whom have rendered excellent service to the industry.

Scientific and Industrial Research

Early this month the work of the Department of Scientific and Industrial Research was reviewed in the Report of the Research Council for 1958.[1] Over two years ago the Council took responsibility for the direction of the Department's work and it now presents a fresh approach to cover the 1959 to 1964 quinquennium. The new five-year plan, it can be noted, involves an increase of 70% in expenditure, a plan designed, it is suggested, to give a greater degree of flexibility. It is felt, indeed, that "expansion should not be tied too closely in advance to specific projects." In a changing world the Department has to be prepared "to experiment with new ideas and to amend its policy and organization as the need arises." In the outcome the £36,000,000 grant for the first five-year plan has been increased to £61,000,000 for the second. It has been decided rapidly to expand grants for research and post-graduate training in the universities and other educational institutions, while the Research Association will also receive more help and the work of the Department's research stations constantly surveyed and directed towards those new fields thought to be growing in importance.

[1] London: H.M. Stationery Office. Price 3s. 6d.

Special notice might be taken of the Council's view of the work of the research stations. In general terms it is suggested that such work should be along three specific lines. There should be research which can help central and local authorities "to supply essential services and protect the welfare of the people," research designed to improve the nation's economic efficiency, and research which will provide industry with basic information on which applied research can the more securely be based. In this connexion particular interest attaches to the new Warren Spring laboratory at Stevenage, now replacing the old Fuel Research Station at Greenwich. There process research and development covering a wide field is to be carried out, with mineral processing and the synthesis of oil from carbon monoxide and hydrogen at first receiving special attention. It is pointed out that over its whole field of work Warren Spring will carry out basic research and in choosing its name the Council has avoided any which might seem to restrict its field of activity. An offer from the U.K. Atomic Energy Authority of staff and equipment from its Mineral Dressing Laboratory at Harwell has been accepted on conditions that include at present an annual contribution from the Authority to cover the cost of work it asks the Department to do on its behalf. The first units moved from Greenwich to Stevenage in November, 1958, and the main transfer was completed by the end of February, 1959. Work on air pollution, however, is expected to continue at Greenwich at least until the end of 1959 and, so long as the old station remains in existence, it will be a branch laboratory of Warren Spring.

Reference to the increased expenditure that is empowered for the next five years has already been made. The expansion will be gradual, from about £9,000,000 in the current year to £14,000,000 in 1963–64. It can be noted that in the first five-year plan, now concluded, the staff of the Department has increased by 20%, although recruitment has not always been easy. In the next five years it will be increased by a further 30%, but the report is able to say that with new talent now emerging from the universities and technical colleges vacancies should become less difficult to fill. The Council is evidently, therefore, determined that the proposals further to support research and development ideas in industry shall have every chance of success.

MONTHLY REVIEW

Introduction. — Reviewing the economic position in his address to a meeting in London of the American Bankers' Association the Chancellor of the Exchequer suggested that in general it is much stronger than had seemed likely a year ago. His efforts to combine economic expansion with price stability are meeting with success and he expressed confidence in the outlook. Meanwhile base-metal prices remain steady at the new levels, dealings in lead and zinc particularly having been sustained by hopes of the United Nations conference in New York.

Transvaal.—The gold output from the Rand and Orange Free State mines in March totalled 1,561,196 oz., making with 32,271 oz. from outside mines a total of 1,593,467 oz. for the month. At March 31 there were 379,257 natives at work in the gold mines, as compared with 396,217 at the end of the previous month.

The report of the UNION CORPORATION for 1958, which shows a total of £1,773,543 available for appropriation and £935,812 distributed as dividends and a bonus equal to 3s. 6d. a share, makes an important announcement regarding its exploration work. In the Kinross area, it is stated, drilling was continued during the year and it is intended shortly to apply to the Mining Lease Board of the Union Government for two new leases. In addition a further lease area is still under investigation.

In his review of operations at ZANDPAN GOLD MINING in 1958 the chairman says that work on the property commenced in October last, the collar of No. 1 shaft having now been completed and the shaft sunk to 198 ft. below surface. Sinking has been stopped temporarily while the permanent concrete headgear is being cast and equipped and surface installations completed. This shaft, which is circular and 26 ft. in diameter, will be provided with a brattice wall to give both upcast and downcast ventilation. It was intended that the shaft would be sunk to approximately 5,000 ft. and that a subvertical shaft would then be sunk to a final depth of approximately 7,500 ft. In order to enable exploratory development to be commenced at an earlier date than would otherwise have been the case it is now intended to sink the surface shaft to the reef horizon, which is estimated to be about 7,000 ft. from surface. When the initial programme has been completed it will be necessary to raise further capital in order to sink a second shaft from surface, to construct a reduction plant, and to provide the housing, services, and facilities required to bring the mine to initial production.

The report of WESTERN DEEP LEVELS for 1958 says that by March 31 last the main shaft of the No. 2 shaft system had reached 3,018 ft. and the ventilation shaft a depth of 2,714 ft. The main and ventilation shafts of the No. 3 shaft system had been sunk to 3,536 ft. and 4,429 ft. respectively. Subject to the current rate of sinking being maintained the consulting engineers estimate that the Ventersdorp Contact Reef should be intersected at about 5,720 ft. below surface in the No. 2 main shaft during the first quarter of 1960. At the No. 3 shaft system the Ventersdorp Contact Reef should be intersected at about 6,420 ft. in the sub-vertical shaft. Before then, however, it is hoped to expose this reef in a cross-cut from the No. 3 Vertical shaft.

DAGGAFONTEIN MINES reports a profit of £4,834,881 for 1958, dividends equal to 5s. a share requiring £1,750,000 of the £5,305,900 available. Production for the year totalled 577,155 oz. of gold and 579,156 lb. of uranium oxide.

Dividends equal to 3s. 6d. a share require £1,837,500 of the total working profit of £3,917,800 earned by VAAL REEFS EXPLORATION AND MINING in 1959, when 881,500 tons of ore was milled and 398,933 oz. of gold and 574,176 lb. of uranium oxide were recovered. The report refers to the commissioning of the No. 2 shaft area. Including the cost of the extension to the gold reduction plant to give it a capacity of 125,000 tons per month and the cost of additional housing for European and Native employees the total cost of the No. 2 shaft system is now estimated at £5,600,000. It is proposed to finance this from profits over a period of years and it is hoped that it will prove possible for dividends to be maintained at about the present level during the new shaft-sinking phase.

A profit of £2,623,483 was earned by WESTERN REEFS EXPLORATION in 1958, dividends equal to 2s. 6d. a share requiring £875,000 of the £3,130,695 available. In the year 1,334,000 tons of ore milled resulted in the production of 319,419 oz. of gold and 690,290 lb. of uranium oxide.

SOUTH AFRICAN LAND AND EXPLORATION made a working profit for 1958 of £655,168, the 1,079,000 tons of ore milled in the year yielding 222,470 oz. of gold. Dividends equal to 3s. a share required £371,250.

The report of EAST DAGGAFONTEIN MINES for 1958 shows a profit of £356,184 and £573,054 available, of which dividends equal to 1s. 3d. a share absorb £233,125. In the year 181,484 oz. of gold were recovered from 1,096,000 tons of ore milled.

Operations at EAST RAND PROPRIETARY MINES during 1958 resulted in a profit of £1,497,232, of which dividends equal to 4s. a share require £792,000. The 2,669,000 tons of ore treated in the year yielded 675,783 oz. of gold. It is estimated that expenditure of a capital nature during 1959 will amount to approximately £1,000,000, which will be incurred on the new reduction plant, shaft sinking, and extensions to the cooling, pumping, and ventilation arrangements at depth.

The accounts of CROWN MINES for 1958 show a profit of £276,577 and £1,482,403 available, of which dividends totalling 3s. 3d. a share absorb £306,495. Milling 2,751,000 tons of ore resulted in the recovery of 420,393 oz. of gold. The report says that the payable ore developed during the year amounted to 530,400 tons and the total ore reserve at 6,487,000 tons was less than that of the previous year by 1,112,000 tons. In view of the limited areas remaining to be developed a consequent decline in the available ore reserve is inevitable, it is stated.

The report of DURBAN ROODEPOORT DEEP for 1958 shows a profit of £576,860. Of the £1,493,859 available dividends totalling 3s. a share require £348,750. In the year 398,322 oz. of gold was recovered from 2,200,000 tons of ore milled.

EAST GEDULD MINES reports a profit of £1,668,299 for 1958, dividends equal to 3s. 8d. per stock unit requiring £1,650,000. The 1,587,900 tons of ore crushed in the year yielded 475,762 oz. of gold.

The accounts of Geduld Proprietary Mines for 1958 show a profit of £842,803 and £1,182,778 available, of which dividends totalling 11s. 3d. a share absorb £821,732. The mill return of 153,791 oz. of gold came from 929,000 tons of ore milled.

The operations of GROOTVLEI PROPRIETARY for 1958 resulted in a profit of £1,322,777. Of the £2,011,992 available for appropriation dividends amounting to 2s. 4d. a stock unit absorbed £1,334,529.

At WINKELHAAK MINES trial milling started in March, 1958, and full-scale work in November. In December the 69,000 tons treated yielded 4·49 dwt. in gold per ton. The report points out that the mill at this mine is unique in that the conventional crushers have been eliminated and the ore is fed directly to the tube-mills. This has resulted in considerable saving in labour, although several minor adjustments have been necessary to obtain the best results.

WEST RAND CONSOLIDATED reports a profit of £1,614,825 for 1958, dividends totalling 4s. 3d. on the ordinary shares requiring £1,204,167. In the year the 2,447,000 tons of ore milled in the gold and uranium sections resulted in the recovery of 247,582 oz. of gold and 1,256,168 lb. of uranium oxide. The report states that during the past three years, under an agreement with West Rand, the ELECTROLYTIC METAL CORPORATION (PTY.) has conducted experiments in a pilot plant to determine the economic possibilities of producing electrolytic manganese from the uranium plant residue. The results of these experiments have indicated that the erection of a permanent plant is justified, the report says, and since the close of the financial year West Rand has acquired a 20% participation in this venture.

With the recent dividend notice shareholders of the GENERAL MINING AND FINANCE CORPORATION were informed that, subject to final audit, the profit for 1958 from the Corporation's normal operations, after providing for taxation and after including £67,381 arising from share dealing, was £1,726,825, as compared with £1,374,745 for 1957. In addition a profit of £870,260 was realized from sales of investments to the AMERICAN SOUTH AFRICAN INVESTMENT COMPANY. It is stated that £845,390 has been transferred to general reserve, £400,000 to investment reserve, £150,000 to exploration reserve, and £150,592 utilized for writing down investments.

Orange Free State.—The accounts of ST. HELENA GOLD MINES for 1958 show a profit of £2,274,536, of which dividends equal to 2s. 1d. a share require £1,002,604. In the year 1,468,000 tons of ore was milled and 429,307 oz. of gold recovered.

VIRGINIA ORANGE FREE STATE GOLD MINING reports a profit of £2,180,993 for 1958. In the year 1,256,000 tons of ore was

treated and 329,052 oz. of gold and 635,279 lb. of uranium oxide recovered.

The GENERAL MINING AND FINANCE CORPORATION reminded shareholders last month that in 1945 diamond drilling on the farms Video 305 and Vermeulenskraal Noord 480, in the Ventersburg district of the Free State, indicated that the area is underlain by the Basal Reef. It is now stated that two further bore-holes are to be sunk on Video with the object of obtaining additional information in regard to the depth and payability of the Reef. The drilling is to be carried out by EASTERN RAND EXTENSIONS, LYDENBURG PLATINUM, and GENERAL MINING, who will share the costs in proportion to their interests in the mineral rights of the two farms—*viz.*, 50%, 25%, and 25%, respectively.

In his address to shareholders of FREDDIES CONSOLIDATED MINES at the recent annual meeting in Johannesburg the chairman, Mr. D. A. B. Watson, said that in present circumstances the directors have considered it advisable to continue operations on a narrow margin of profit or loss rather than face what might be an equivalent expenditure on closure and caretaking.

South-West Africa.—The operations of the SOUTH WEST AFRICA COMPANY for the year ended June 30 last resulted in a loss of £470,847. After transferring £500,000 from reserve and making other adjustments a credit balance of £48,790 is carried forward.

Northern Rhodesia.—ROAN ANTELOPE COPPER MINES reports an estimated profit (before taxation) of £3,342,000 for the nine months ended March 31 last. In the period 59,281 long tons of copper was produced and 59,281 tons sold. In the same period MUFULIRA COPPER MINES, producing 61,357 tons of copper, made a profit of £4,695,000 and CHIBULUMA MINES, producing 12,527 tons, a profit of £560,000.

RHODESIA BROKEN HILL reports an operating profit of £769,553 for 1958 and dividends equal to 9d. a stock unit require £487,500. In the year 12,675 long tons of lead, 30,250 tons of zinc, 17 tons of cadmium, and 54,784 oz. of silver were produced. The report states that tests on Broken Hill materials were carried out in the experimental blast furnace of IMPERIAL SMELTING at Avonmouth and showed that this type of furnace is technically suitable for the treatment of Broken Hill concentrates and intermediate products. The new process would be able to make a high recovery of metal from currently produced ore and also be able to deal with large tonnages of previously stockpiled materials, at present untreatable.

It was reported last month that agreement on the exploration of areas in Northern Rhodesia covered by coal-mining rights had been reached between the RHODESIA–KATANGA COMPANY, the RIO TINTO COMPANY, and the BRITISH SOUTH AFRICA COMPANY. As to the Kansanshi copper mine, which is still on care and maintenance, the pilot plant for the treatment of the difficult ore structure is expected to be constructed in the middle of the current year. Then if the pilot-plant work, expected to be complete by the end of 1959, proves the treatment process practicable, the economics of installing a full-scale plant is to be examined.

Ghana.—The operations of AMALGAMATED BANKET AREAS in the year to September 30 last show a profit of £162,640 and a credit balance of £1,187 carried forward. In the year 739,760 tons of ore was milled and 172,754 oz. of gold recovered.

ARISTON GOLD MINES (1929) reports a profit of £242,800 for the year ended September 30 last, £196,172 of the £437,655 available being required for dividends equal to 6d. a stock unit. During the year 474,920 tons of ore was treated and 148,684 oz. of gold recovered. To finance the development programme now planned the company proposes an issue of shares on " favourable bonus terms." It is thought that approximately £200,000 is needed.

The accounts of WESTERN SELECTION AND DEVELOPMENT for the year to September 30 last show a profit of £95,128 and £172,529 available. Of this amount a dividend equal to 8% requires £45,938 and after other allowances a credit balance of £116,870 is carried forward.

India.—Earlier this month the RIO TINTO COMPANY announced that it had come to an agreement with the Board of the METAL CORPORATION OF INDIA for the provision of technical and commercial services for the expansion of the Zawar lead-zinc deposits in Rajahstan and the erection of a zinc smelter in that area. It is intended that Rio Tinto should subscribe to 40% of the equity of the Metal Corporation of India and a similar shareholding would be held by the INDIAN STEEL AND WIRE PRODUCTS CO., LTD., of Tatanagar.

Spain.—During 1958 the THARSIS SULPHUR AND COPPER COMPANY shipped 568,044 tons of pyrite. Shareholders are informed that, with the completion of the crushing installa-

tions and the construction of the mineral storage deposit, the North Lode Opencast is approaching production stage. At Centre Lode removal of overburden has been carried out throughout the year and it is expected that some cupreous ore from this source should be available during the closing months of the current year. The profit amounts to £122,728, which, with the balance brought forward from the previous year of £200,187 and the credit from taxation provisions of £100,901, makes a total of £423,816. After the payment of a dividend of 12½% there is a balance of £228,113 to be carried forward.

Cornwall.—Shareholders of GEEVOR TIN MINES have been informed that, subject to the approval of stockholders and to confirmation by the Court, it is proposed to make a capital repayment to stockholders of 4s. 6d. in respect of each 5s. stock unit and then to restore the nominal amount of capital to its original amount by means of a capitalization issue.

SOUTH CROFTY reports a loss of £51,575 for 1958, which increases the debit balance brought in to £80,022. In the year the 75,596 tons of ore treated yielded 742 tons of black tin.

Chartered and the Union Corporation.—The directors of the BRITISH SOUTH AFRICA COMPANY and of the UNION CORPORATION, LTD., have agreed, subject to approval by their respective shareholders, that the Union Corporation should issue to a subsidiary investment holding company of the British South Africa Company the 700,000 ordinary shares of 2s. 6d. each at present in reserve and that in exchange the British South Africa Company should issue to a subsidiary of the Union Corporation 455,000 ordinary shares of 15s. each at present in reserve.

Rio Tinto Company.—The consolidated accounts of the Rio Tinto Company and its subsidiaries for 1958 show a profit of £1,470,000 and £3,282,000 available. Of this amount £754,000 is required for dividends, equal to 1s. 6d. per ordinary stock unit, leaving £2,528,000 unappropriated.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated.)

Aluminium, Ltd.—Quarterly, 12½ cents, payable June 5.
***Ayer Hitam Tin Dredging.**—4d., payable May 15.
†British-Borneo Petroleum.—20⅝%, tax free, payable July 2.
†Broken Hill South.—4d. Aust., payable June 25.
†Central Provinces Manganese Ore Co.—1s. 8d. and 4d. bonus, free of tax, payable June 10.
†Chicago-Gaika Development.—15%.
†Consolidated Zinc Corporation.—2s., payable July 1.
†General Mining and Finance Corporation.—4s., payable June 4.
***Gopeng Consolidated.**—3d., payable May 29.
†Great Boulder Gold Mines.—30%.
†H.E. Proprietary.—12½%, payable June 11.
†Henderson's Transvaal Estates.—15%, payable July 16.
***Kentan Gold Areas.**—7½%, payable June 19.
***Lampa Mining.**—5%, payable June 1.
***Mary Kathleen Uranium.**—1s. 3d., payable May 22.
***Messina (Transvaal) Development.**—4s., payable June 14.
***Mount Isa Mines.**—6d. Aust., payable June 29.
†New Broken Hill Consolidated.—10d., free of tax, payable July 1.
†North Broken Hill.—2s. 6d. Aust., payable June 24.
†Oceana Development.—10%, payable June 2.
***Pahang Consolidated Co.**—2½%, payable June 6.
Premier (Transvaal) Diamond Mining.—Pref. 12s. 6d., payable May 28.
Rio Tinto Co.—†1s. 6d. and *6d., payable June 4.
†Selayang Tin Dredging.—15%, payable June 17.
***Sungei Besi Mines.**—4½d., payable May 12.
***Tanganyika Concessions.**—1s. 6d., payable June 5.
†Tharsis Sulphur and Copper.—12½%.
†Transvaal Lands.—20%, payable June 16.
†Tweefontein Colliery.—Pref. 9·6d., Ord. 4s. 6d., payable July 9.
†Union Minière du Haut-Katanga.—Fr. Cong. 1,500, payable May 29.
†Western Selection and Development Co.—8%.

METAL PRICES

May 8.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	28	10	0
Silver		6	7⅛
Gold	12	9	4¼
Wolfram (U.K.)		—	
(World)	4	12	6

Tin, Copper, Lead, Zinc — See Table, p. 300.

Roof-Bolt Failures and Their Prevention

G. C. Sen, M.Sc.[1]

The author discusses the usual causes of failure and reviews preventive measures

Introduction

Although the application of roof bolting has been successful generally there have been a few cases of failure of the system. It should be pointed out, however, that most of the failures occurred during experimental periods and few accidental failures actually resulted in personal injury.

Failures

Where failures have occurred they have indicated potential hazards and the following are the more common causes observed :—

(*a*) *Roof Bolting in Roads with Solid Coal-Rib Sides.*

The effects of strata movements along longwall roadways often causes breaks and lines of weakness in the roof in close proximity and parallel to the rib (1).[2] The abovementioned fracture is due to the strength of the coal beyond the rib compared to a pack on the opposite side of the gate. The presence of such breaks shows that the roof beam is already broken. Whilst there is no conclusive evidence that the effects are similar in all seams and strata, it is generally agreed that rib-sides do create lines of strong resistance and excessive shear stress. Hence, roof bolting in a rib-side roadway should not be practised.

(*b*) *Props Underneath Bars which are Roof Bolted.*

The main principle of roof bolting is to bind the laminations of rock together to form a beam. It is necessary, however, to allow normal subsidence of the bolted beam and the best way of doing this would be to avoid setting supports under the ends of the roof bars. But the regulations for support in a roadhead require support to be set at least within 10 yd. of the working face and to comply with this props are usually set under the ends of bolted roof bars. It should be noted that such rigid props under the bar may induce shear breaks in the bolted beam and consequently destroy the *beam effect* desired by the roof bolting.

In practice, the object is achieved by the use of soft wooden lids between the props and roof bar to accommodate the subsidence without the *beam effect* being damaged and remove these props when the face has advanced further inbye. In other cases, the face props holding the ends of roof bolted bars are set on top of yielding elements so that the props penetrate readily and allow for the subsidence of the roof beam. Examples are the use of hydraulic props or *stilts* on rigid steel props.

(*c*) *The Use of Insufficient Number of Bolts.*

Experience shows that 90% of the failures in roof bolting investigated in U.S.A. are in this category (2). The failures generally result from not having or carrying out a pre-determined pattern of bolting but rather depending upon the judgments of individuals in placing the bolts. The remedy is efficient supervision to enforce the pattern of bolting strictly.

At Four Star mine (Canada) roof bolting was tried in a 12 ft. wide development work (3). The bolts, 3 ft. 6 in. long, were put three in a row, 4 ft. apart and the rows were on 4 ft. centres. The section of the roadway, where this pattern was followed, stood very well over a long period. Next, it was decided to try a system with two bolts in each row, 2 ft. 6 in. centres, but after several days the bolted roof collapsed over a length of 20 ft. The rock fell to a parting 4 ft. above the coal and was still held together with the bolts, which proved that the two-bolt system was

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[2] Figures in parentheses refer to the References given at the end of the article.

insufficient in number to hold the entire width of the roof beam.

If a roof break is detected in a bolted section, the usual practice is to use some additional patch bolts to anchor the affected roof above the possible bed separation plane.

(*d*) *Clearance between Sides and Roof-Bolted Bars.*

It was observed in an investigation at Colliery A that roof bolts supporting some bars were broken off and that the ends of these particular bars were in contact with the sides of the roadway. Movement of the strata had caused a certain amount of side-squeeze which bent the bars and broke the bolts. The roof bolts were more frequently fractured by the rib-side of the roadway than by the waste side and this no doubt is because of the greater resistance of the side formed by the rib-coal than the more yielding pack on the opposite side of the road. Fig. 1 shows the effects referred to on the roof-bolted bars at Colliery A, whilst the photograph, Fig. 2, shows the roof bolt sheared-off at the contact point between the bar and the bolt-thread. Fig. 3 shows the sheared-off bolt-end with nut and bearing plate.

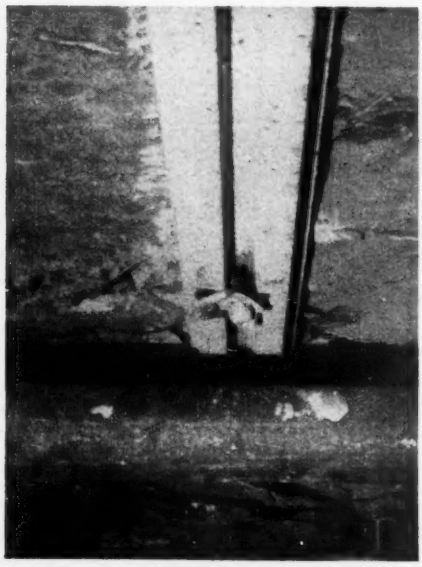

Fig. 1.—Lateral Stress in Action on Roof-Bolted Bar from the Rib-Side Wall.

It was also observed during the investigation that the maximum lateral movement of roof-bolted bars was 3·5 in. which indicates that there should be a clearance of say 6 in. between the ends of a roof-bolted bar and the side to avoid bending of the bars from side pressures and fracturing of bolts in consequence.

(*e*) *Weakness in Roof-Strata Parallel to a Road.*

An example of this occurred where roof bolting was used in the centre gate of a longwall face in a 2 ft. 6 in. seam (1). The gate packs were 10 yd. wide and the wastes were caved ; the roof was of shale of moderate strength. It was supported by 16 ft. long channel girders each secured by five bolts. Props were set to the ends of each girder initially but removed outside the roadhead area. A length of 200 yd. of road had been supported by this method, but for the last 50 yd. a small fault developed a few feet from the side of the road over the right-hand pack. Falls occurred which necessitated a good deal of repair work.

During the repair work it was found that a block of strata, 5 ft. 6 in. thick, the full width of the road was left with the bolts still attached to the girders. Above this block the ground, which had to be filled out during the repair work, showed two pronounced slips, one on each side of the road, heading towards the road and terminating at a strong bed 15 ft. above the seam. Therefore where such natural weaknesses or faults occur in a direction parallel to the road, care should be taken to retain conventional supports with the roof bolting.

(*f*) *The Effects of Cross-Measure Drives.*

Roof bolting in a cross-measure drive needs care because of changes in the character of the strata passed through. At a Colliery B 180 yd. of roof was bolted in a cross-measure drive and stood for over two years. However, a 20 yd. length fell to a height of 8 ft. soon after installation. The location and cause of the failure was the unexpected appearance of a 10 in. thick coal seam in the strata into which many bolts had been anchored. As a result of this occurrence it has become the practice that when a coal seam is encountered during drilling the roadway is supported with steel arches 3 yd. in front of and behind its intersection with the drive.

(*g*) *Faulted Ground.*

The efficiency of roof bolting in faulted ground has exceeded expectations (4). In Hartley Bank colliery (N. Eastern Division) when a fault is encountered a narrow entry of about 1 ft. 6 in. wide is driven in the heading to a depth of about 2 ft. and patch bolting installed. The entry is then widened out on either side and further patch bolts installed. By this means, permanent supports can be set ahead of the general line of working face and before the roof beds have a chance to move. If the roof is particularly friable, corrugated sheets are bolted to the roof or side. These patch supports are additional to the channel girders set at regular intervals of 3 ft. The bolts are generally 7 ft. long and usually inclined over the sides of the road. This method has proved very successful.

(*h*) *Time Lag between Roof Exposure and Bolting.*

At all times bolts should be put in right up to the face and wherever practicable before machine-cutting of the coal so that the roof beds are not given a chance to move and separate.

A fall in a roof-bolted roadway in Prosper III Pit (Germany) occurred about three months after the roof bolting installation (5). One of the main causes of the fall was attributed to the excessive length of time the road was open before roof bolting. During this time the lower roof beds sagged considerably and as soon as the back abutment pressures started to act the whole system failed.

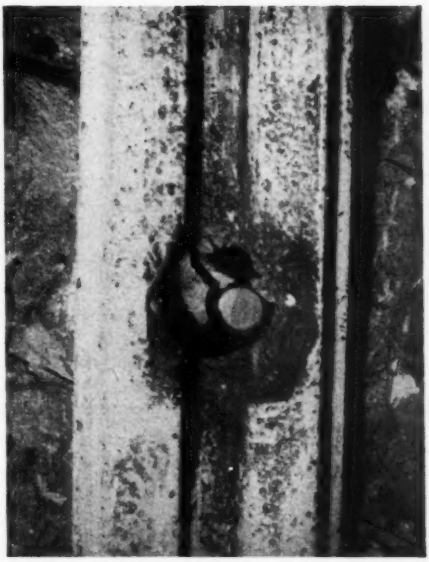

Fig. 2.—Sheared-Off Roof Bolt and Its Bar.

(*i*) *Observance of Visual Signs of Failure of Roof Bolts.*

These should be noted and remedial measures applied.

At the annual meeting of the Coal Mining Institute of America it was claimed that in all instances indications of failure of bolting showed up in advance, either as visual

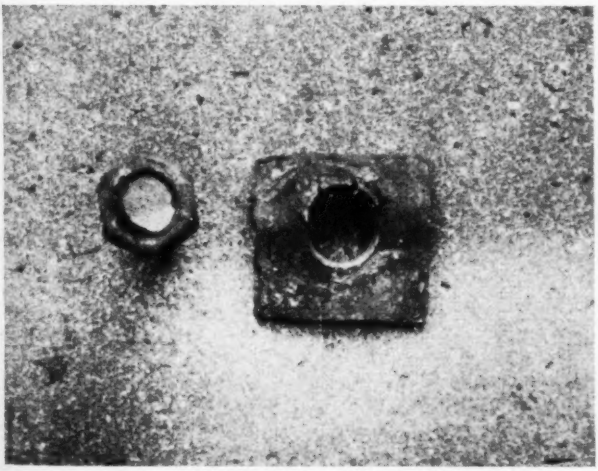

Fig. 3.—Sheared-Off Bolt-End, with Nut and Bearing Plate.

breaks in rib-sides and roof or as a humming sound in the bolts (6).

Some accidental failures of roof bolts have been preceded by visual compression and tensional cracks along coal-ribs and near the middle of roadways. Failure of bolted roof often preceded by the " piano wire " tensing of bolts (6). Testing of bolts with a torque wrench would also show that they have little or no tension and they are not regaining the lost tension before failure.

(*j*) *Corrosion of Bolts.*

When water or moisture is present in the roof it may run down the drill holes and hence the bolt and this might cause rusting of the bolts. The problem is worse if acid waters are present. Galvanized bolts may help in this problem.

Conclusions

A few instances of failure of strata bolting have been reported and a review of such failures has at least afforded some useful information. If proper care and vigilant supervision are followed then the potential hazards of the failure of roof bolting can be avoided.

Acknowledgments.—The author would like to thank the personnel of the National Coal Board and in particular Dr. W. A. Terrell, Mr. W. Rason, and Mr. H. Light for their valuable co-operation and help.

The author expresses his thanks to the Board for permission to publish this article. Opinions expressed are the author's own and not necessarily those of the National Coal Board.

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Long-Hole Test Drilling at Beaverlodge

Low-cost lightweight drills and rope-threaded flexible steels make increased exploration economically possible

R. G. Chambers

The technique of using lightweight drills, rope-threaded extension steel, and sludge samples for exploration drilling has proved its economic value in many countries other than Sweden, where it originated. In the uranium producing area of Beaverlodge, in Canada's far north, for instance, the technique is often more than an economy; in some instances, at least, it has been a veritable life saver, enabling mines short of reserves to find much needed ore that otherwise would be missed. In terms of the arithmetic of several Beaverlodge mines the equation is something like this: Cost of diamond drilling per ft., $2·75; cost of long-hole drilling with extension equipment and sludge testing approximately $1·00 per foot.

The long hole-sludge type of exploration does not, of course, supplant diamond drilling, because it indicates mineralization but not structure. It does, however, complement it. In effect it enables some of the mines to do two to three times as much exploration work as they could afford if they were depending on diamond drilling alone.

For many years the Atlas Copco group of companies, in co-operation with Sandvik, have devoted considerable effort to the development of long-hole drilling equipment for use with pusher-leg rock-drills. Recognizing the need for convenience, mobility,

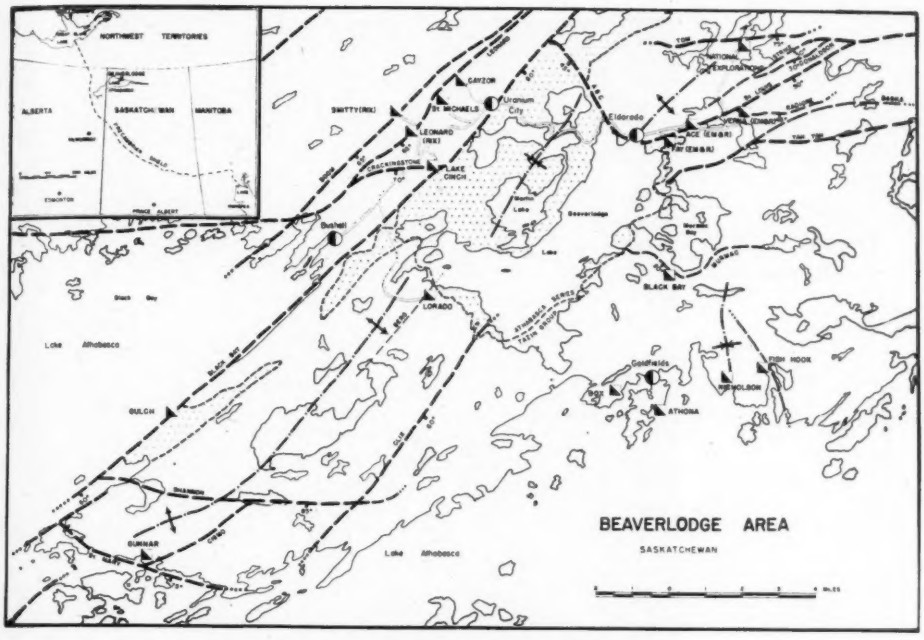


Fig. 1.—Beaverlodge Area : showing structure lines.

and manœuvrability in confined working areas, they have developed a threaded steel connexion using $\frac{1}{2}$ in. pitch rope thread with steels ranging upwards in length from 5 ft. These threads are so designed that they effect a solid but easily detachable rod connexion. Couplings are also smaller, making possible the use of smaller bit diameters. This in turn results in high drilling speed. It is this type of equipment that is proving effective for deep test holes at Beaverlodge.

Rock structure and ore disposition make this technique particularly effective in the Beaverlodge area. Here the ore tends to be erratic with no clean-cut line of demarcation between ore and waste. In this kind of ground the lower cost of the process makes more exploration possible. There are other advantages : The lightweight equipment can be moved readily from place to place. Requiring only 6-ft. width for operation, it can be set up and used conveniently in working areas and moved quickly to permit other use of the area. Just as quickly it can be put back into operation. This procedure is not possible with the heavier and larger equipment required for diamond drilling. As a result several of the Beaverlodge mines do test-hole drilling from working stopes and rises.

The Rix Athabasca, which became the first privately-owned uranium producer in Canada when it came into production in April, 1954, has used this technique with considerable effectiveness. During 1958 this mine did 5,700 ft. of test-hole drilling at an average cost of $1·03 cents per ft. This figure included the cost of assaying. In contrast diamond drilling costs $2·70–$3·15 per ft. in this mine. Much of the work was done in drives and rises and, in the elusive ore of the Rix, unearthed several high-grade pockets which otherwise would have been missed. Fig. 2 shows a pusher-leg drill using extension equipment at this mine.

One of the conclusions reached at Rix—and other mines—was the preference for sludge sampling test holes over probing with a geiger counter. It was found that the geiger probe had limited reliability while the sludge process gave 50%–60% recovery. Normal practice is to take a sludge sample every 5 ft. For this purpose, for example, one of the mines drives a collection hole in a 30° angle to intersect the drill hole. Special canvas

Fig. 2.— Drilling in Progress at Rix-Athabasca.

sample bags are used and tagged for identification purposes. Fig. 3 shows the position of a collection hole in relation to a test hole, the former being collared about 6 in. below the test hole. Most of the sludge is recovered in the sample bag on a spigot fixed in the collection hole. Sludge losses may result during the decantation of fines out of the sample bag or from small holes in the bag, a poor seal between rock and hose used as spigot, or the transport of sludge on drill steel back to the machine. Nevertheless the recovery is adequate and sufficiently reliable for the purpose.

Experience at the Rix has indicated that a normally competent miner can quickly be trained to do test drilling. Certain handling procedures must be followed closely or broken steel will result but this has not been a serious factor here or at the other mines in the area. The Rix pays a bonus of 10 cents a foot for drilling on the level and 15 cents per foot for drilling in rises and stopes. Coupled to this is a penalty against the miner if steel breakage is excessive. So far both the miners and the mine appear to be happy with the result.

Drilling ranges from 100 ft. to 120 ft. per day per machine and test holes of 30 ft. to 50 ft. are preferred at this mine. Holes are normally patterned at 50 ft. intervals. Fig. 4 shows test holes in one section of 203 drive on the second level of the Leonard mine. Dotted lines show test holes, solid lines indicate mineralization. Geologists proved the information regarding the line and depth of the hole and the drillers prefer to drill 30 in. to 36 in. from the floor. Experience has proved that when the machine is set up and arrangements made for sludge samples the following procedure should be followed :—

First part of hole is drilled with series 4 or extension equipment ; extension is used more frequently.

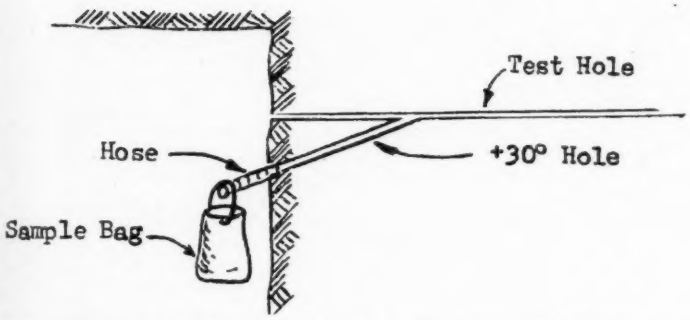


Fig. 3.— Sludge Collection.

Couplings must always be in the hole, threaded fully on forward rod before rear rod is threaded.

Rods must be butting before drilling begins.

Holes must be flushed clear before resuming drilling after a rod section is added.

Throttle must be opened slowly; feed pressure constant and firm.

1-in. hose is used to ensure fast drilling and adequate feed pressure.

Careful attention must be given to lubrication; lubricants for threads used are Aerox 56 rock-drill oil with graphite powder or Esso rock-drill oil.

Rods are rotated systematically—*i.e.*, the extension rods are used in a different sequence in each hole.

Extension equipment is washed down with water before starting hole.

Preference is for four-winged bits—although two mines in the area use chisel bits. It is desirable also to use the smallest possible bit.

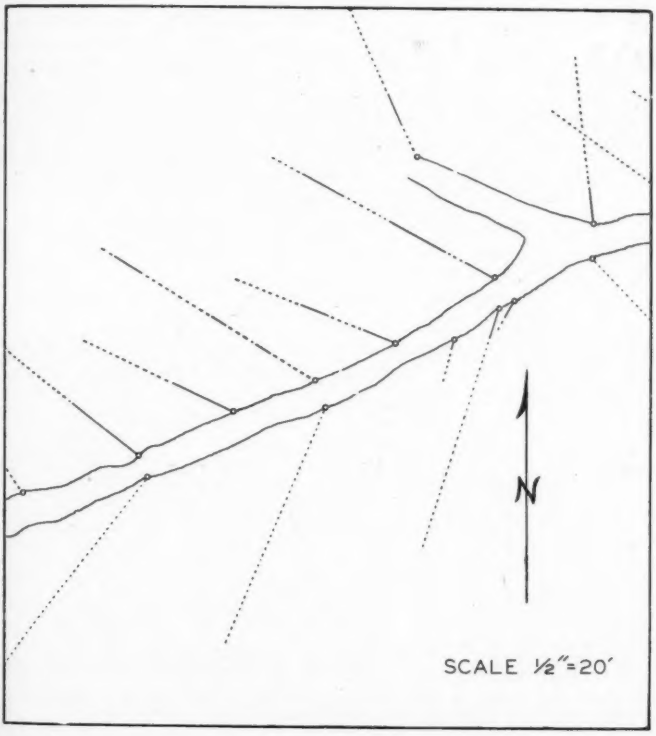


Fig. 4.— Test Holes in the Leonard Mine.

Following this procedure one shift at the Rix was able to connect up air and water, drill 53 ft., move 200 ft. to another site, set up and drill 53 ft., move gear to another level, set up and drill a third 53 ft., all within an eight-hour shift. Taking the sludge samples was included in the performance.

Rix is only one of the several uranium mines in the Beaverlodge area using this technique. The Verna mine of Eldorado Mining and Refining also uses the long-hole testing method to achieve less costly exploration of stope walls. Using Lion drills with short and long air legs and Coromant hexagon hollow steels, the mine reports that the process provided desired information at about one-third the cost of diamond drilling. An added bonus is that assays are available one day earlier. As a result the technique has introduced greater flexibility and permitted more extensive and complete testing than provided by diamond drilling.

The majority of the test holes at the Verna have been in argillite, generally fine bedded, soft, and moderately fractured in "ore rock," a feldspar and haematitic altered argillite, dense, hard, and moderately too strongly fractured, and in siliceous feldspar rock, microcrystalline, extremely hard and weakly fractured. Since July, 1958, the record has showed the average hole length to have been 40 ft., the shortest hole, 10 ft., and the longest hole, 80 ft. The maximum *plus* inclination has been *plus* 25° and the maximum *minus* inclination 0°, with an average per man shift of 43 ft. At this mine all the long-hole test drilling is on a contract basis, with the contractor bearing all the costs of breakdowns, delays, and supplies. As a consequence cost per foot is difficult to determine.

The long test holes themselves are laid out in the geologist's office and are located underground using surveyor stations and 100-ft. tape. The foresight, backsight, length, and inclination are marked on the stope or drive wall with paint. "Quik Spray" paint bombs have been found to be quite effective for this purpose.

The Lake Cinch Mines, in the same general area, regularly drills test holes to 100 ft. in depth using Lion rock-drills with Coromant rope thread extension steel. Here, however, the usual procedure is to inter-space the holes between diamond-drill holes. Both are drilled in patterns of 100 ft. providing a test hole every 50 ft. When the rock structure is known the company will drill a complete pattern with extension steel to outline the ore-body. Four-wing bits are preferred in this mine and sludge samples taken every 4 ft. Samples are partly dried and tested with a geiger counter. Samples indicating a grade of 1·02% U_3O_8 or better are assayed. Colour and content of graphite or carbonate are recorded on the hole log together with the assay. The holes are not probed.

Costs of long-hole test drilling with rope-threaded extension steels at Lake Cinch in 1958 were $0·993 cents per ft. This cost included steel, bits, machine write-off, labour for drilling, and preparing drill sites. Air and water costs are not included in these figures. Average monthly drilling is about 900 ft.

The results in the Beaverlodge uranium-bearing area present a favourable record of the use of rope-threaded extension steels for long-hole test drilling where ground conditions permit. Here, as in Sweden, the birthplace of lightweight equipment and extension steels, experience has proved that in many instances the technique can be most inexpensive method of complementing diamond drilling. Added to this are the convenience of the lightweight equipment, the ease of handling, speed of drilling, mobility and reliability of the technique which have been useful factors in the process of enabling these mines to meet production and budget schedules.

Sheffield Exhibition

A private exhibition is being staged by the Mond Nickel Company at the Cutlers' Hall, Sheffield, from June 2 to 5, featuring the properties of nickel, nickel-containing materials, the platinum metals, and spheroidal-graphite iron. The Inco-Mond organization, of course, produces almost half of the free world's production of the platinum metals, so that the exhibition has been designed to feature the range of the company's products and to illustrate the special properties which make them vital materials. The exhibition is divided into sections dealing with mechanical and physical properties, corrosion-resistance, electro-deposition, strength at high temperatures, toughness at sub-zero temperatures, and welding, the main sections being further subdivided. Each day a number of technical films is to be shown relating to various aspects of the exhibition.

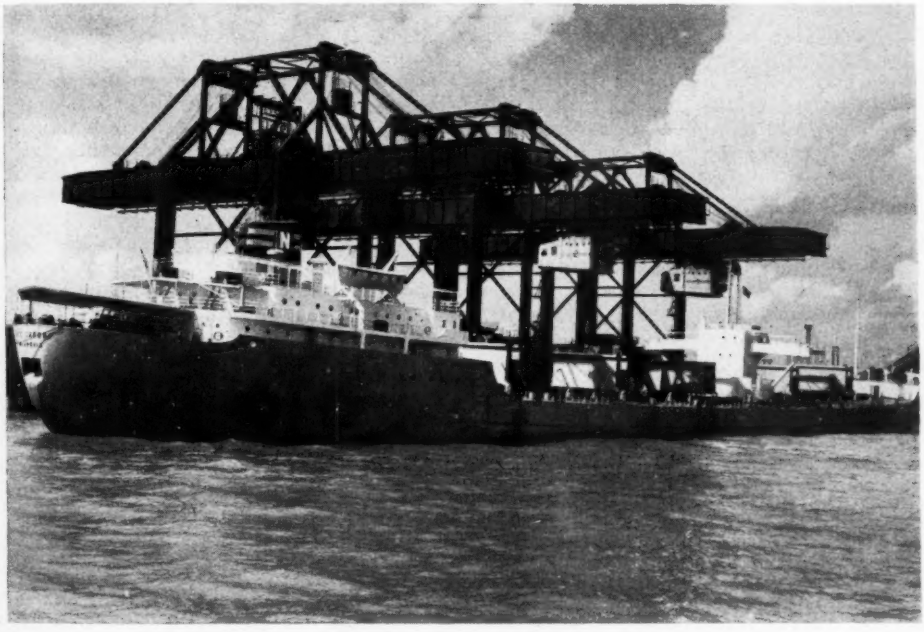
Ore Handling at a Virginian Port

J. Grindrod

Imports of iron ore into the United States through Newport News have been facilitated

Although for many decades most of the iron ore used by the United States has been, and still is, mined on the North American continent and shipped to the Middle Appalachian States iron and steel works by way of the Great Lakes, increasing quantities are now being imported from overseas. To speed this growing flow of imported ores, the Chesapeake and Ohio Railway has recently placed in operation a new pier at Newport News, Virginia, which is claimed to be one of the most modern and efficient of its kind in the world. Incorporating the best features of American and European designs, this Pier No. 9 and its ore unloaders, costing $8,500,000 to install, is said to set new standards of speed and flexibility for the handling of bulk cargoes.

Whereas the importation of ore is a new development in the United States the continent of Europe has always been obliged to import supplies from overseas and before undertaking the task of building their new facilities at Newport News, the railway studied ore-unloading methods and equipment, not only in America, but also in Europe. As a result of these investigations the company decided to purchase three ore unloaders from DEMAG, of Duisberg, Western Germany, while the necessary belt-conveyors and the wagon loading tower were ordered from the Wellman Engineering Company in America.



Unloading Ore at Newport News.

C. and O. Ore Pier Lay-Out.

With these new facilities chrome, manganese, iron, and bauxite ores as well as other bulk materials can be unloaded at more than a ton a second.

The new finger-type ore unloading pier at Newport News has an overall length to the end of the dolphin structure of 1,191 ft. It consists of a 725 ft. long 82 ft. 4 in. wide (over fenders) section on which the three unloaders operate, together with an extension for the mooring of vessels waiting to be unloaded. The unloading section is made up of an asphalt deck on steel sheet pile cells filled with sand and gravel and reinforced concrete tower runways on steel " H " piles. Goodyear rubber dock fenders are used.

Of the slewing jib type, used extensively in European ports for discharging ore and coal from ships, the three mobile unloading transporters can discharge two vessels berthed on either side of the pier simultaneously. The slewing jib trolley used in each of the unloaders carries a load of 33 tons (including bucket), which is twice as much as the conventional European trolley will carry and it can take out of the ship's hold 18 tons of ore every 45 seconds.

Each transporter is equipped on both sides with projecting aprons which can be raised and which have an effective reach on each side of 86 ft. 6 in. The transporters each have a middle span of 64 ft. and clear head room of 77 ft. between the rail level and the underside of the apron. Each of the slewing trolleys runs on a 16 ft. 5 in. wide track and carries a 190-ton gondola which moves back and forth on the trolley and which rotates on ball bearings in a full circle, giving the trolley an operating radius of 18 ft. The bucket is suspended from a short boom or jib attached to the gondola and, with this arrangement, it is possible to reach almost anywhere in a ship's hold without moving the bridge. The arrangement also makes it possible for the operator, who rides in the nose of the gondola and has full view of the work, to dig the ore to a plane, instead of trenching back and forth as is customary with many unloaders. By thus maintaining a level surface, efficiency is also greatly improved.

To achieve its high rates of operation each transporter is powered with an installed electric capacity of 2,100 h.p. Details of speeds and power for the various individual operations are given in Table 1. It is said that the American operators greatly appreciate the comfortable and convenient German-type control chairs which are little known in the United States and do much to reduce fatigue.

Table 1

Operation	*Speed (ft./min.)*	*Power (kW)*
Lifting	296	450
Closing	279	240
Trolley travel	558	2 × 240
Trolley slewing	2·5 (r.p.m.)	18
Transporter travel	92	2 × 61

The ore buckets have low centres of gravity when open and a very wide span in proportion to capacity. They are relatively light and depend on mechanical design rather than on weight for their penetration into the ore. Nine buckets are available in all and their capacities are given in Table 2. Special linkages in the holding and closing lines make it possible to change buckets in less than five minutes, so that the optimum size bucket can be used for each specific operation. Special trimming grabs of 8·5 cu. yd. capacity and with a maximum jaw width of 23 ft. speed up the time-consuming final clean-up of the hold

Table 2

No. of buckets	*Capacity (cu. ft.)*	*Open Width*	*Weight (lb.)*
3	245	23 ft.	30,800
3	200	22 ft. 8 in.	28,600
2	80	18 ft.	16,000
1	200	32 ft.	28,600

without auxiliary equipment aboard ship. This contributes greatly toward reducing the high cost of trimming.

Ore is transferred by the slewing trolleys from the holds of the vessel to a hopper installed between the legs of the transporter. Thence, it is passed to slat conveyors and reciprocating feeders which deliver it on to two longitudinal steel cable reinforced belt-conveyors. These are nearly 1,000 ft. long and 3 ft. 11 in. in width and operate with a belt speed of 10 ft./sec., each having a capacity of 3,600 tons per hour and providing a lift of 90 ft.

The longitudinal conveyors transport the ore to the wagon loading house located inshore, where there are two 600/900 ton (depending on the type of the ore) storage bins, electronic scales and four 45-ton capacity weighing hoppers. The conveyor-belts are so arranged that the ore flow from either may be directed to either bin. This arrangement contributes to operating flexibility and makes it easier to keep various grades of ore segregated. By way of 72-in. manganese-steel feeders the ore may be loaded into railway wagons of all sizes, two at a time.

In addition to the new ore unloading facilities at Newport News the Chesapeake and Ohio Railway has recently considerably augmented its loading facilities for export coal. Coal from the mines of West Virginia and Kentucky can be loaded into vessels at a maximum rate of 6,000 tons per hour (average loading capacity 4,000 tons per hour) at Pier No. 14 and at a maximum capacity of 5,500 tons per hour (average loading capacity 3,000 tons per hour) at Pier No. 15. Wagons bringing coal to Newport News are, after discharge, thoroughly flushed out with water at 100 lb. p.s.i. before being loaded with ore for the return journey to the interior. The new ore unloading installation is regarded as a new development in ore handling inasmuch as it dispenses with a storage area serving as a " balancing reservoir." The arrival of wagons can be regulated to meet the ore-handling capacity of the plant and the requisite number of empty wagons is always assured.

Anaconda's Berkeley Pit

H. G. Jarman

Expanded operations at this project in Montana now yield 17,500 tons of ore a day

Known as the " richest " hill on earth since mining was first started back in 1880 Berkeley has already yielded over 14,428,919,640 lb. of copper, 4,374,985,738 lb. of zinc, 2,555,985,062 lb. of manganese, 752,929,707 lb. of lead, 606,764,032 oz. of silver, and 2,249,763 oz. of gold. Now a mammoth man-made pit is taking a giant slice from the eastern end of this hill at Butte, Montana. The huge excavation, when stripping is completed, will measure 4,600 ft. by 2,000 ft. at its perimeter and will be mined as deep as 490 ft. The Berkeley Pit, as the new operation is called, marks the beginning of open-pit mining in an area long associated with deep shaft work.

Berkley pit is but one phase of the Anaconda Company's " Greater Butte Project," a long-range programme designed to extend the life of Butte's copper operations for many years. Ton for ton it costs much less to get the ore out of the pit than from the deep shaft mines, while open-pit mining enables Anaconda to utilize lower-grade ore than can be economically obtained from underground. Approximately 100 tons of pit ore must be blasted and hauled to the crusher and then milled, afterwards being transported to storage, shipped, and refined to produce 1 ton of 98% blister copper. Dependable materials-handling equipment geared to a high tonnage capacity makes the successful and economical operation of this open mine possible. From the truck dump hopper ore is fed to the primary crusher through intermediate surge storage facilities, stockpiled, reclaimed, and delivered into loading bins by a material-handling system designed especially for this particular operation. This system, equipped with heavy-duty

components and rated at 1,800 tons per hour, consists of a series of six belt-conveyors and six manganese-steel apron feeders, each equipped with dribble belts. At present about 26,000 tons of primary crushed ore is being handled over the system.

In designing the Berkley pit ore transportation system provisions were made for a flexibility of flow patterns. Several methods of handling the ore are possible : (1) Direct from crusher to car loading bins ; (2) from crusher to outdoor stockpiles ; (3) reclaiming from stockpile to car loading bins, or (4) simultaneous reclaiming from stockpile while handling ore direct from crusher—both material streams feeding to the tripper belt over the car loading bins. The area between the crushing plant and the tracks of the Butte Anaconda and Pacific Railway, where the loading bins are located, contain four railroad tracks and a main highway.

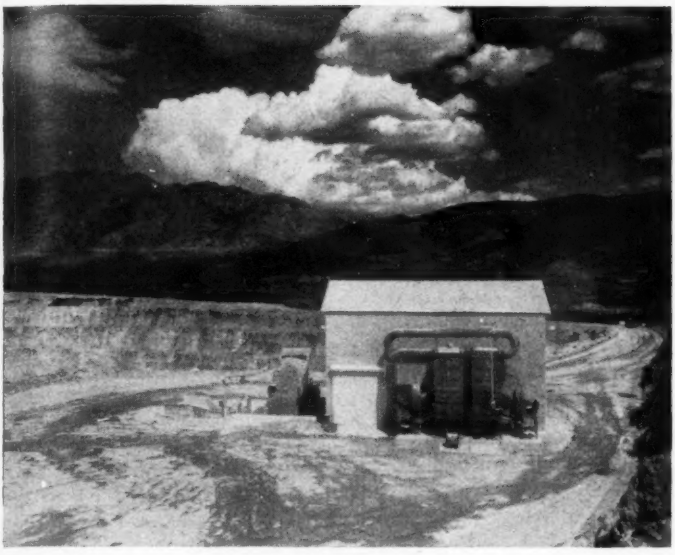
An ore transportation layout was required that would avoid these facilities with safety and minimum interference, both during and after the construction period. This problem was solved by driving a 610-ft. concrete-lined tunnel on a 12° slope to the bottom of a crusher pit. A 46-in. wide conveyor-belt in this tunnel runs under the highway and three of the four railway tracks. The fourth rail line, near the car loading bins, is crossed by overhead conveyor galleries.

After the ore in the pit has been drilled and blasted it is loaded into 35-ton off-highway trucks by 6-yd. electric shovels. The large vehicles haul the material from the pit to a truck hopper on the surface which serves the crushers. Trucks can dump on three sides of this hopper. A " wobbler " unit in one end of the hopper receives ore which contains timbers from old underground workings. These are removed from the wobbler and the coarse ore passes over the unit to a heavy-duty manganese-steel apron feeder. This is supported by heavy I-beams, which are spring-mounted and can handle up to 2,500 tons per hour of 24-in. maximum-size ore. Heavy shock loads on the feeder resulting from the trucks when they are dumping simultaneously are cushioned by this supporting arrangement.

Handling a 5-ft. deep bed of material the feeder discharges on to a vibrating screen, with oversize going into a 60 in. by 84 in. jaw-crusher, the crushed ore flowing into a 380-ton concrete-lined storage bin. Material passing through the wobbler unit as well as dribble from the apron feeder is collected on a troughed belt-conveyor and carried to the crushed-ore bin.

Crushed ore is reclaimed from storage by another manganese-steel apron feeder and discharged through a grizzly on to a flat belt-picking conveyor equipped with an electronic metal detector. A large electro-magnet is suspended over the head pulley to remove any tramp metal on the picking belt, while pieces of timber not removed at the

Conveyor Galleries, Transfers, and Ore Bins.



Truck Dumping Into Crusher Station.

wobbler are pulled from the belt by the operator. Ore and dribble from the apron feeder are discharged to the main haulage conveyor-belt.

The conveyor system for stockpiling or bin storage on this extensive operation consists of five main conveyor systems. The main haulage belt-conveyor is 48 in. wide and 1,037 ft. long on inclined centres and extends for 610 ft. into the concrete-lined tunnel. Then for the remainder of its 1,037-ft. journey it goes to the drive house in a covered gallery. The conveyor is driven by two 300-h.p. motors through two single-reduction parallel-shaft speed reducers connected to the drive pulley shaft by quintuple wide precision steel roller chains.

Ore may be discharged from conveyor No. 1 to a concrete slab at ground level to form a 35,000-ton conical outdoor stockpile under the drive house, or it may be fed on to shuttle-belt conveyor No. 5 which is 60 in. wide on 20-ft. centres. This short conveyor transfers the ore to conveyor No. 2, a 48-in. by 550-ft. long belt which goes to the transfer house near the car loading bins. Conveyor No. 2 then discharges through a specially-designed transfer hopper to conveyor No. 4, a 60-in. wide by 199-ft. long belt, which is equipped with a specially designed heavy-duty self-propelled travelling-tripper. The tripper is rated at 3,600 tons per hour to handle material flows from conveyors Nos. 2 and 3 simultaneously when required.

As the ore discharges from the tripper the flow is split by an inverted "V" arrangement, half the flow going through a chute on one side of the tripper and the remainder into a chute on the other side. The tripper traverses 130 ft., feeding two rows of 11 circular V-bottom car loading bins, equipped with air-operated loading gates. The car loading bins are constructed to permit two-side loading of 70-ton gondolas. These bins provide 5,000 tons of storage for railway car loading.

Ore from the outdoor stockpile of 5,000 ton capacity is reclaimed by four heavy-duty manganese-steel apron feeders which discharge to conveyor No. 3, which is a belt 48 in. wide by 575-ft. centres. The four apron feeders are mounted in pairs and declined 10° on either side of conveyor No. 3. With a material bed-depth of 5 ft. 6 in. each feeder can handle from 400 tons to 1,200 tons per hour, depending entirely upon the speed at which it is being operated. Conveyor No. 3 extends 180 ft. in a tunnel and the remainder of its 575 ft. in an enclosed gallery. This belt discharges to conveyor No. 4 through the same transfer hopper as conveyor No. 2.

The transfer hopper at the receiving end of conveyor No. 4 is a double chute arrangement to handle material from conveyors

Nos. 2 and 3. This hopper is provided with three shelves (rock-boxes) which fill with material. Subsequent trajectory of the material from both belts strikes the ore built up in the rock boxes, thereby reducing chute wear to a minimum. Another reason for the use of the rock-box design is to prevent an excessive fall of the material on to the tripper belt. Abrasion-resisting liner plates are used on this transfer hopper as well as on the transfer chutes at the discharge end of conveyor No. 1.

The complete ore-handling system at Berkeley pit was designed and built to continuous 24-hour-per-day operation, with a minimum of shutdown time due to maintenance or equipment replacement.

Underground workings in the Butte mines now total almost 41 miles of vertical shafts, together with 2,500 miles of other passageways. Adding the excavation from slopes brings the total length of underground workings to more than 9,250 miles. At the 2,800-ft. level it is possible to travel five miles east to west from mine to mine under the heart of Butte City with its 33,000 population.

Ore-Dressing Notes

(16) *Gravity Concentration.*

Sluicing Action

This present note is the first of a short series considering the principles incorporated in some of the more common appliances used in mineral processing plant and from this foundation to trace the requirements for functional efficiency, running control, and maintenance. The purpose of this series is to act as a " refresher course " rather than to break new ground.

Since all concentrating processes include an element of gravitational force, it is convenient to commence the survey with one of the oldest machines used in purely gravitational differentiation of moderately finely ground material—the shaking table. It is not always recognized that beneath the appearance of a reciprocating plane with its pattern of riffles we are dealing with the most ancient concentrating device known, the sluice. When critical attention is given to a single longitudinal riffle on the table deck this fact becomes clear. To understand table action it is, therefore, useful to begin with study of a stationary sluice, free of riffling, and with a down slope instead of an unbalanced reciprocating motion to aid the passage of feed from delivery to discharge. The comparison is imperfect, since only part of the sluice's feed goes through to discharge, and that the lighter fraction, whereas the separating system built into table riffles allows other forms of escape. Nevertheless, unless simple sluice action is understood, scientific control of the shaking table cannot be reasoned out.

The acting forces with respect to a single free particle in the channel of the sluice are (*a*) gravitational acting vertically and (*b*) hydraulic, exerting longitudinal pressure. The gravitational force depends on the volume and specific gravity of the particle. The hydraulic thrust applied by the current of water as it runs down the slope depends on (*a*) current speed, (*b*) the cross section of a particle presented from moment to moment normal to the current, (*c*) the area of a particle in rubbing contact with the water, and (*d*) the shape of the particle. The " shape factor " influences the mode of progress of the particle through the sluice; a marble would roll smoothly, a prism across stream would roll jerkily, or if aligned with the current would slide, and a cube or thickly tabular particle would slide or skip. If highly-efficient sluice action were required, it would therefore be essential to consider the size, shape, and density of each species of mineral in the feed, using broad statistical averages to evaluate the information given by examination under the microscope. This refinement would not be practised in the rough operation of sluicing, of course, but it can have its place in table control. The extreme example of shape influence is, perhaps, the ability of a light thin flake of mica to slide straight across a shaking table regardless of the tilt which is affecting much denser particles of similar mass.

Returning to the sluice action, the elements of separatory control now become clear. The particles, although moving in millions in their

turbulent, jostled progress, broadly respond to the influences discussed above, provided the sluice is so manipulated that they are exposed to those influences. They must not be allowed to pack down, but must be kept in sufficiently fluid teeter to allow the hydraulic action to reach them. At the same time they must not be so much disturbed by the forces used to open up the sluice bed that they cannot stratify in the ascending order (i) smallest heaviest, (ii) largest heaviest and smallest middling, (iii) largest middling and smallest lightest, and (iv) ascending sizes of lightest. This arrangement results from what Gaudin in his textbook calls " consolidation trickling " and can readily be understood in the light of Newton's and Stokes's laws, as modified by particle shape. In the writer's experience, however, most operators approach the control of the shaking table without first considering the governing principles of sluice action and as a result must rely to an undesirable extent on trial-and-error adjustments when the feed changes.

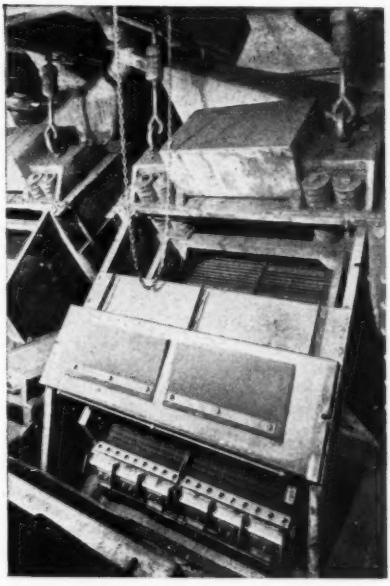
One of the factors listed above—(*c*) area of particle in rubbing contact with the water—is of major importance in deciding on the mode of feed preparation. If homogeneous material of density 3·0 is sized closely, and the particles are of the average prismoidal shape, the area in square metres of a kilogram. of sized sand is 2·73 m.^{2} at 20 mesh, 15·4 m.^{2} at 100 mesh, 43·5 m.^{2} at 270 mesh, and 200 m.^{2} at 10μ (sub-sieve size). Thus it is readily seen that a frictional urge which would hardly affect the coarse sand becomes a strong transporting agent with respect to the finest material. At the same time the mass of the largest particle gives it the greatest resistance to displacement in this series, an effect diminishing in proportion to the cube of the mean mesh. In respect of each particle, then, frictional transport is facilitated by both loss of volume and relative increase in ratio of area to weight. This relationship must be considered both for the gangue mineral and the values, and must be studied in terms of their respective densities, shapes, and abundance in the sands which are to be treated. For a given sluicing operation to succeed, pre-sizing or pre-classification (usually the latter) must produce sluice-head sands of such a size range that the hydraulic action at a given slope will only move the lighter sands. In the next of these Notes these considerations will be tied in with action on a shaking table.

(17) *Screening.*

Use of Electric Heat

A limiting factor in ordinary fine screening in the mill is the blinding due to moist ore. Drying does not necessarily provide a solution since it may consolidate the desired undersize into non-disintegrating lumps. One remedy is the use of electric current conducted along the wires of the screen in order to maintain a temperature of between 30° and 40° C. Higher temperatures are possible, but precautions must then be taken to prevent overheating when the feed is interrupted.

An installation at Penlee Quarries, Penzance,[1] uses electrical heating on standard



Heating of Lower Deck of a Gyrex Screen.

4 ft. by 10 ft. mechanically vibrated screens double-decked with $\frac{7}{32}$-in. and $\frac{3}{32}$-in. cloths of square-mesh high-tensile steel wire ; some 30% of the feed is *minus* $\frac{1}{16}$ in. In wet weather the lower screen was blinded in half an hour's working and even under dry conditions the dust-suppressing sprays in the transfer conveying points set up trouble. The overall moisture was about 5% but the fraction of this in the " fines " was over 10%.

[1] See " THE MINING MAGAZINE," Aug., 1958, p. 117.

With the use of electric heating at 40° C. the throughput from four screens is 25 tons/hour at a cost of three farthings per ton with power at 1d. per unit and the *plus* $\frac{3}{32}$ in. material is virtually free of undersize.

In another reported case *minus* $\frac{3}{8}$ in. coal is sized on $\frac{1}{16}$-in. screens, electrically vibrated. Before the application of heat to this feed, which carries from 4% to 7% water, screening was practically impossible. To apply the method the screen cloth is insulated from the frame in two separate longitudinal sections and the upper end is connected to a source of low-tension electricity. At the lower end the screen is connected to the parallel panel, from the top of which the connexion runs back to the supply busbars. Ore is fed a few inches below the upper edge of the screen and replacement of the cables is only needed at long intervals.

(18) *Ion Exchange.*

Fixed and Moving Beds Tests

In a recent article C. W. Hancher [1] considers the laboratory approach to ion-exchange column design and describes some of the forms of apparatus which have been developed for testing work. Fixed bed IX is limited by the possibility of preferential flow through the column. This leads to incomplete saturation of parts of the resin at a time when some of it is fully loaded to the point where discharge has reached the safe limit. Thus a relatively small percentage of the resin is correctly saturated at the point of stopping. When the resin is stripped the second undesirable effect is that the concentration in the pregnant liquid is lower than it should be because the stripping process has had to deal with the highest concentration and again with possible channeling. In designing continuous counter current IX contactors the length of resin bed for a given separation must be determined. This can be done by means of a diagram which gives a graphical resolution of the number of successive theoretical stages in the separation process. These are arrived at by isolating stages on the balanced operating line against the equilibrium line (the McCabe-Thiele diagram). Continuous from this point of view are those in which the resin is moved intermittently by an outside force and counter-current to the liquid flow. They are called continuous systems because the resin moves at regular closely spaced intervals. The percentage of bed moved per cycle varies from 25% to 0·5%. This short note should serve to direct the attention of those interested to a highly specialized mode of investigation.

[1] *Engg Min. J.*, Mar., 1959, p. 80.

Book Review

Economics for the Mineral Engineer. By E. J. Pryor. Cloth, octavo, 254 pages, illustrated. Price 35s. London : Pergamon Press, Ltd.

In his preface the author states that this book, written primarily for students of mineral dressing, " is designed to present the elements of the economics of mineral engineering, set in its place in the whole industry of mining." This excellent objective he tries to attain in 12 chapters, a glossary, and a short bibliography, covering a total of 248 pages of interesting reading. The wide scope of the book can be gauged from a glance at some of the chapter headings, which range through " Prospecting, Sampling, and Valuation," " Accounts and Organization," " Mill Records," " New Construction," and " Marketing the Product " to " Managerial Skills." To cover this variety of subjects the author has called largely on his own experience, supported by extensive reading as evident from the numerous extracts from quoted references and the text is alive with descriptive anecdotes and personal comments.

It is the wide scope of the subject matter that partly defeats the object or, better perhaps, submerges it, to an extent that suggests that the title of the book may not be a true description of its contents. It is really more a guide to consultants, for it covers—sometimes superficially and sometimes in detail—very many of the problems encountered in connexion with design and management of mineral engineering enterprises. That the author himself really aims at a far bigger audience than he has stated in his preface is evident throughout the book and tacitly admitted in the introduction to the Glossary " included for the guidance of non-technical administration "—a useful idea, though some of the items—such as, the Greek alphabet, Frasch Process, and Claggy—seem a little incongruous. Consequently there appears to be an occasional lack of balance and unevenness in the style of writing, possibly because the author himself

has from time to time visualized different readers and has adjusted his style accordingly. For example, the chapter on prospecting includes some very elementary geology and a detailed description of Banka drilling (but, curiously, a very brief reference to diamond drilling), which seems unlikely to be of interest to the mineral dressing student, who can be presumed to cover such aspects in much greater detail during his technical training. On the other hand, the last two chapters, dealing with " Managerial Skills " and with sub-headings such as " Service Contracts," " Professional Status," and " Technical Writing " are clearly directed at that student—and what a wealth of worldly wisdom they contain! A factual description of the structure, machinery, and responsibilities of the Trades Unions would have been useful in addition to the author's views on the subject in this section.

In a book touching so many subjects it is not surprising that there are points of detail which would be regarded as controversial and omissions of items considered essential by some. The precise methods of calculating mill balances, including the various formulae that may be used in different circumstances, would seem to be an important aspect to be covered in detail with examples; so also, perhaps, the full significance of the " call," a fuller description of the Gant chart, with examples, and for the non-technical reader the meaning of such terms as " liberation-mesh," " dense media separation," etc. The author's interpretation of " Quality Control " would probably not be accepted in mathematical circles and many operators will be surprised at the omission from the managerial structure of the quite indispensable chief or " resident " engineer, although much of the text deals with engineering details. Also the possibility of direct communication between consultants and the mill office would be considered by many to require such delicate handling as to be dangerous.

Such criticisms do not, however, detract from the value of the book; rather do they add spice to the reader's appreciation of the many valuable opinions and facts collected here. The volume is well presented with few detected printing errors and in readable print on good quality paper. The failure to insert page numbers when referring to illustrations in the text is irritating, particularly as the figures are often printed several pages away from the descriptive data and I would prefer to see literature references collected at the ends of chapters or in a final appendix to the book rather than distributed at random at the bottoms of pages. Such minor defects should not discourage all those interested in the mineral industry from reading this book and those who do so will find much to absorb, much to think and argue about, and much to benefit from; I expect to see it on many bookshelves.

F. D. L. NOAKES.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Letter to the Editor

" Geological Aspects of Mining "

SIR,—May I say, as a University teacher of both geology and mining students, that in my opinion your review of this book in your December issue is inadequate and misleading. Nothing is said of the many mistakes in spelling, terminology, and fact in the chapters dealing with geology which are apparent even on a cursory glance through the book. The tables on pp. 12 and 70 have some odd features, to say the least, while Figs. 6A and 6B on p. 15 do not seem to have much to do with the text on p. 14, and Figs. 78, 98, and 103 are incorrect. The subject of underground water, surely important in mining, is barely mentioned, and the list of references on p. 184 quite inadequate. One would think that in a book with this title some reference should be made to Trueman's *Coalfields of Great Britain* or the works of Lindgren, Bateman, and McKinstry.

The author of the book says on p. 1 " A little knowledge should not, however, be allowed to become a dangerous thing, and when confronted with a very intricate geological problem . . . it is wise to have conclusions vetted by an expert." The presentation of the principles of geology in a textbook is an intricate geological problem.

P. McL. D. DUFF.

GRANT INSTITUTE OF GEOLOGY,
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February 27.

Engineering Log

An annual event at the Hall of Worshipful Company of Goldsmiths in the City is the trial of the Pyx. At this samples of coinage made at the Royal Mint during the preceding year are tested for composition and weight. The tests have been performed since Edward I's reign in the 13th Century and possibly earlier. At one time only gold and silver coins were tested but since 1946 cupro-nickel has been added. Until 1920 sterling silver contained 925 parts per thousand of that metal but from 1920 the standard was reduced to 500 parts per thousand. By 1928 the alloy was 500 parts of silver, 400 of copper, 50 zinc, and 50 nickel. In 1946 the cupro-nickel coinage took the place of " silver " coins and a 75 copper to 25 nickel ratio is now used. The old true silver coinage is gradually being called in and replaced and only the Maundy money is now made of silver. These are the coins—pennies, twopences, threepences, and fourpences—given to as many old people as there are years in the Sovereign's age—one penny for each year—and distributed by the Queen on Maundy Thursday, in the week before Easter, usually in Westminster Abbey. In 1958 about 2,000,000 gold sovereigns were minted in order to maintain a dying craft and these were, therefore, represented at the trial of the Pyx. This testing is additional to that which goes on daily at the Royal Mint and which is sufficiently thorough to make the trial of the Pyx something of a formality. In an average year about 4,000 lb. weight of cupro-nickel is tested at the trial and is derived from the batches of coins minted. The word Pyx is derived from " Pyxis "—a box. The small bags containing the samples from each journey or minting are kept in a chest or box until presented at the trial. This is conducted by a Jury of 12 or more members of the Worshipful Company of Goldsmiths. Selected coins are weighed in lots of 12 troy oz. to an accuracy of 0·001 oz. and a number are then assayed. The rest of the coins are weighed in bulk in 1,000-oz. lots, special weights being provided by the Standards Department of the Board of Trade. A gold sovereign has a nominal fineness of 916·66 Au with a tolerance of 2 parts per thousand. For cupro-nickel there is a tolerance of 1% of each constituent. Some two months after the trial the verdict is delivered at the Goldsmiths' Hall in the presence of the Chancellor of the Exchequer, who is the Master of the Mint. The Clerk of the Goldsmiths' Company reads the verdict, after which the Jury is discharged by the Queen's Remembrancer. The first recorded trial was held in 1248 although something was being done earlier. It probably took place in the Pyx Chapel at Westminster Abbey which was once the stronghold of the Exchequer. From 1603 to 1699 the trial was held in the Star Chamber. Since 1844 it has been held at the Goldsmiths' Hall. Imperial gold coins from Australia, New Zealand, and Southern Rhodesia are included in the trial.

* * *

On December 7, 1958, President Eisenhower approved a plan for improving the availability of scientific and technical information in the United States. The plan is based on findings of the President's Science Advisory Committee, chairman Dr. J. R. Killian, and reinforces provisions of the National Defense Education Act, 1958. The Act calls for the setting up of a Science Information Service in the National Science Foundation, to " provide, or arrange for the provision of indexing, abstracting, translation, and other services leading to a more effective dissemination of scientific information and undertake programmes to develop new or improved methods, including mechanized systems, for making scientific information available." The President has now furthermore directed the Foundation to take the lead in co-ordinating information activities for science within the Federal Government and asked the co-operation of all Federal agencies concerned with scientific information. The action of President and Congress is very much in line with points raised in November at the International Conference on Scientific Information in Washington, when 1,000 scientists and information experts met to discuss problems of storing and retrieving information. The conference was sponsored by the American National Academy of Sciences, National Research Council, National Science Foundation, and the American Documentation Institute. It opened with an address by Sir Lindor Brown, biological secretary to the Royal Society, who emphasized the possibility of selective storing of the vast and growing output of scientific information, provided this is done with the

co-operation of both user and maker of information. He said that much needless literature is produced and of that which is justified 80% could be improved by drastic reduction of length and increased clarity. He urged scientists to publish their work once only and not many times in many forms.

* * *

The significance of Sir Lindor Brown's address and of the President's action are emphasized by reference to some remarks of Dr. Killian's on the volume of scientific literature currently appearing—55,000 journals annually, containing some 1,200,000 articles relevant to some branch of research. In the same fields over 60,000 books are published annually. About 100,000 research reports do not reach normal channels of publication and cataloguing. Much of this ocean of information, part of it in Russian, Japanese, and other languages with which the English-speaking scientist is unfamiliar, contains the data which scientists need to do their work. The Library of Congress collection of science and technology periodicals provides a rough index of the rate of growth of the material; they have doubled every 20 years for the last century. They now contain 1,500,000 volumes, 15,000 more are received annually, and 1,200–1,300 new periodicals are appearing every year. It is expected that by 1979 the world output of periodicals will reach the figure of 100,000. The mounting flood threatens to swamp even the most active researchers; yet the free flow and full exploitation of the available information is of vital importance to progress in science. The 14 major scientific abstracting services in the United States are estimated to cover, with their 500,000 abstracts, perhaps 55% of what is needed for reasonable coverage. The President's Committee does not believe that a single, centralized, government-financed agency like the Soviet All-Union Institute of Scientific Information would fill the bill. Instead emphasis will be on co-ordination and financial assistance in the publication of periodicals and monographs, including experimental techniques of publication, world lists, classified and indexed, and the provision of a clearing-house for foreign scientific information, with photocopying, indexing, abstracting, and translating services. Attempts would be made to expand inter-library exchanges throughout the world. Government reports would be given special attention and, in addition to the services of information dissemination and retrieval, a programme of research sponsoring would be supported by the organization envisaged in the Committee's report. What is now contemplated in the United States is timely. It goes far beyond the present scope of the Department of Scientific and Industrial Research in Britain and is comparable to the scope of Aslib (the Association of Special Libraries and Information Bureaux), several of whose members took an important part in the Washington conference. It is to be devoutly hoped that the American report will assist the Advisory Council for Scientific Policy in impressing on our Government the need for urgent and adequate action.

* * *

The Soviet rocket which is now in orbit around the sun represents a new stage in man's advance into space. The rocket was freed from earth's gravitational field by achieving a speed of 7 miles per second. Rockets used in launching the man-made earth satellites required a speed of rather less than 5 miles per second. With the relatively small increase to 7½ and 8½ miles per second it will be possible for rockets to travel to any part of the solar system. The orbit of this first solar rocket is like that of the earth but more elliptical. While the distance between earth and sun varies from 91,500,000 miles to 94,500,000 miles, that between rocket and sun will vary between 91,500,000 miles and 123,250,000 miles, so that its year will be a 15-month one. In its voyage round the sun it will fall behind the earth and the earth will catch up again after about 920 days from the launching date. Because of disturbances caused in its orbit by other planets it is unlikely that the rocket will ever return to earth. The solar rocket weighed 3,245·2 lb. and was the ninth space vehicle to be successfully launched into orbit.[1]

* * *

A United States Weather Bureau meteorologist, Mr. M. J. Rubin, has recently reported the finding of the first positive evidence to indicate an Antarctic land mass of continental dimensions by Russian scientists.

[1] *Scientific American*, Feb., 1959.

Rubin has returned from a 15-month tour as liaison scientist at Mirny, on the east coast of Antarctica, Soviet station for the International Geophysical Year. Speculation among scientists had previously suggested the existence of a great area of land beneath the Antarctic ice cap, which is thousands of feet thick; and United States scientists had found that the western part of Antarctica comprised a series of islands. Now a Russian team has made its way across an extremely difficult region of the ice cap's surface, some 1,400 miles of the eastern sector between Mirny and the Pole of Inaccessibility, making seismic soundings every 30 miles to 50 miles. The soundings were made by drilling to a depth of about 200 ft. through the snow and ice, exploding a charge at the bottom of the hole, and recording the echoes sounding from the earth beneath. The land was found to begin some 200 miles in from the ice cap's edge. Levels of the land varied from sea-level to about 10,000 ft. above sea-level. This high level occurred at the Pole of Inaccessibility and here the ice cap was found to be 3,000 ft. thick, having been found in other areas to be as much as 14,000 ft. thick. Rubin found the Mirny Russians as friendly and co-operative as were the scientists of all the nations in the Antarctic. A Russian meteorologist was exchanged for Mr. Rubin and assigned to the United States Little America station.

Four-Rope Friction Winder

The four-rope tower-mounted friction winder illustrated here is the first of its type to be erected in South Africa. Installed at the No. 5 ore shaft of the West Driefontein Gold Mining Co., Ltd., it was designed and manufactured by the Erith Works of the General Electric Company, the electrical equipment being manufactured and supplied by the Witton, Birmingham, works of the same company.

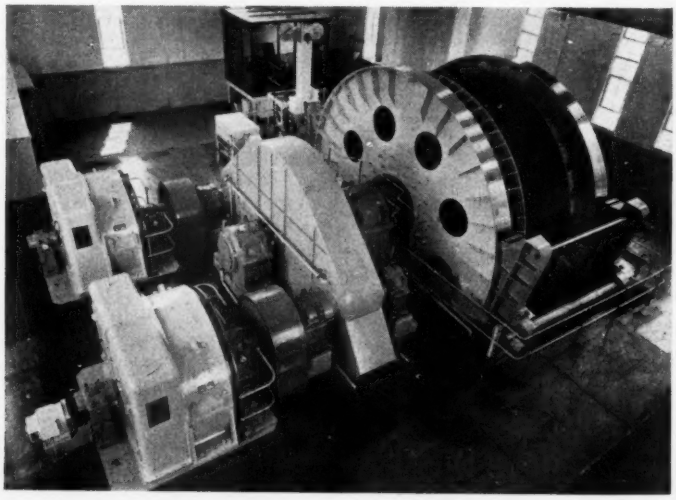
The winder was put into service early this year. Driven by two d.c. motors, each of 2,050 h.p., with forced ventilation, it is capable of raising ore, in balanced skips holding 14 tons each, at the rate of 330 tons an hour from a depth of 5,400 ft. As illustrated the winder was being used for shaft-sinking operations before being put into service as a friction winder.

News Letters

VANCOUVER

April 13.

Legislation.—The 1959 Spring session of the British Columbia Legislature adopted several bills of interest and concern to the mining industry. Bill No. 102, "An Act to Amend the Mineral Act," contains Provisions that have softened to a considerable degree the harsh terms of the much-criticized Bill No. 91 of the 1958 legislative session, which had introduced a leasing-tenure system to



Friction Winder at West Driefontein.

replace the Crown-grant system that had prevailed throughout the life of the Province. Bill No. 43, "An Act Relating to Trade Unions," provides that a trade union or an employers' organization is a legal entity for purposes of prosecuting and being prosecuted for offences against the "Labour Relations Act" and for purposes of suing or being sued under the "Trade Unions Act." Persons and organizations are liable in damages for infractions of either Acts and limitations have been placed on picketing and ex parte injunctions. Bill No. 44, "An Act to Amend the Workmen's Compensation Act," substantially amends previous provisions for medical appeal and provides for medical appeal by either employer or workman on grounds of extent of functional disability, the period for which compensation should be allowed, or that previous medical opinion was erroneous or incomplete. Dependants' allowances are increased and the former ceiling on earnings is raised from $4,000 to $5,000.

Cominco.—Sales of all products of the Consolidated Mining and Smelting Co. of Canada, Ltd., and of its wholly-owned subsidiary companies amounted to $103,900,459 in 1958, as compared with $118,858,460 in 1957. The principal items included 134,827 tons of lead, 193,514 tons of zinc, 69,962 oz. of gold, 12,875,160 oz. of silver, 643 tons of cadmium, 86 tons of bismuth, 458 tons of antimony, 360 tons of tin, 656,697 tons of solid fertilizer, and 45,714 tons of liquid fertilizer (all short tons). After providing for income and mining taxes and depreciation of plants, the consolidated net profit for the year was $14,017,883; dividends paid during the year amounted to $13,104,257. Although the tonnage of metal sold during the year was only slightly below that for 1957, the marked decline in the average prices received for both lead and zinc had an adverse effect on the company's earnings. In 1958 provisions for depreciation exceeded capital expenditures on plant and mining investments. Partly as a result of this the net working capital increased $7,384,769 during the year to $92,318,055 at December 31 last.

The tonnage of ore extracted from the Sullivan mine at Kimberley was 2,443,884, as compared with 2,423,577 in 1957; the low-grade open-pit operation remained closed. Underground development and backfilling continued at a rate required to maintain the present rate of production and a pillar blast of more than 800,000 tons, the largest in the history of the mine, was successfully fired in July. Production from the Bluebell lead-zinc mine at Riondel was 255,859 tons, as compared with 256,118 tons in 1957, while at the H. B. zinc-lead mine, near Salmo, production was 458,213 tons, against 451,381 tons in 1957.

Ore treated at the Con mill, at Yellowknife, aggregated 188,497 tons, as compared with 183,914 tons in 1957, the ore treated in 1958 including 119,082 tons averaging 0·54 oz. of gold per ton from the Con mine and 69,415 tons averaging 0·71 oz. per ton from the Rycon mine. An option was acquired on the N'Kana group immediately north of the Con mine and underground exploration is in progress.

The phosphate mines in Montana continued to supply the phosphate rock required by the company's fertilizer operations. The installation of new facilities for improved haulage was delayed by poor ground conditions, but should be completed by early 1960. Additional phosphate leases were acquired to provide for long-term reserves.

An active programme of exploration in search of new mines was continued; 17 properties were optioned out of 105 examined and company prospectors staked an additional 18 properties. Development work, including nearly 38,000 ft. of diamond drilling, was done on 24 properties. In New Brunswick underground exploration is contemplated on an ore-body outlined by previous surface work. In B.C. diamond drilling gave encouraging results on one property in the Lardeau area and further work is planned. Underground exploration confirmed the indicated ore on the copper property of Sunro Mines, Ltd., near Victoria. No work was done on the zinc-lead property of Pine Point Mines, Ltd., in the Northwest Territories.

Mr. R. E. Stavert, the Cominco president, states :—

> Considering the difficult conditions which prevailed in the world lead and zinc markets during the year, the company's sales of these metals were satisfactory and were about the same as in the previous year. As a result, year-end inventories were normal. Major market distributions of combined metal sales were 27% to Canada, 32% to the United States, and 38% to the United Kingdom.

Skeena.—The annual report of Torbrit Silver Mines, Ltd., for 1958 shows a production of 1,331,088 oz. of silver and 1,506,849 lb. of lead from 135,892 tons of ore grading 11·61 oz. of silver per ton with 0·65% lead. The gross value of output was $1,335,617

($1,683,903) and the operating expenditures including local taxes were $1,197,593 ($1,397,024). After provision of $89,749 ($215,517) for depreciation and $72,113 ($83,600) for outside exploration, the year's operations resulted in a net loss of $23,838 ($12,238). Earned surplus at December 31, 1958, was $1,640,274 ($1,664,112). (Figures in brackets are for 1957.)

Ore reserves at the year-end were estimated at only 45,582 tons grading 12·46 oz. of silver per ton. Of this tonnage, 37,198 was already broken in stopes and 2,000 tons of the remainder was drilled but not blasted. Salvage of the original Toric mine should be completed by early summer, but encouraging results of exploration and development on the adjoining North Star claim could have an important bearing on lengthening the life of the operation.

Vancouver Island.—Shareholders of Cowichan Copper Co., Ltd., have approved the purchase of control of four other Vancouver Island mining companies—Nadira Mines, Ltd., Avallin Mines, Ltd., Caycuse Copper Co., Ltd., and Cellardor Mines, Ltd. The properties of the first three named are situated within easy trucking distance of the Cowichan mill; the Cellardor property is south of Duncan. Each of the four companies is capitalized at 5,000,000 shares, of which the individual share issue varies from 1,200,000 to 1,250,000 shares. Cowichan Copper is capitalized at 3,000,000 shares, of which 1,984,225 shares had been issued prior to entry into the current action. The company will issue a further 480,000 shares to acquire its control position and will then proceed to sell some 500,000 capital shares to provide a fund for the development of the newly-acquired properties. The proposal permits Cowichan to designate its operating profit for the development of further reserves in the Cowichan mine; to utilize spare concentrating capacity for the treatment of development ore from the properties of the subsidiary companies, and to gain tax concessions through exemption on new production.

The Haulpai Enterprises Corporation has obtained a lease on mining claims owned by Canadian Collieries Resources, Ltd., and is planning an early mining and shipping operation from the Nootka Sound property. The iron concentrate, to be produced in a mill installed on a barge moored at a wharf two miles from the open-pit mining operation is to be sold to Japanese smelting interests. The operation is not extensive and is expected to be in production this summer at an estimated cost of $250,000.

Nimpkish Iron Mines, Ltd., plans shipments of iron concentrate to Japan to commence this summer. The company holds a contract to deliver 1,000,000 tons to Japanese purchasers without restriction as to time. The property is advantageously situated near the north end of Vancouver Island and will make use of a logging railway to loading facilities at Beaver Cove. Nimpkish is a private company and is owned by Standard Iron Mines, Ltd., a subsidiary of the Standard Slag Co., of Youngstown, Ohio and Rhoda Iron Mines, Ltd., a subsidiary of International Iron Mines, Ltd., the latter a Canadian company.

Nelson.—The estimated profit from the lead-zinc mining operations of Canadian Exploration, Ltd., at Salmo, for the nine-month period ended January 31, 1959, was $247,100; this compares with $883,000 in the same period of the previous year. The profit was determined after making provision of $124,800 ($271,400) for exploration expenditure, $400,000 ($600,000) for depreciation, and $113,700 ($576,000) for federal and provincial taxes, and deducting the total from estimated gross profit of $885,600 ($2,330,400). (Figures in brackets cover the first nine months of the previous year.)

Reeves MacDonald Mines, Ltd., produced 23,520 oz. of silver, 7,973,619 lb. of lead, 28,220,124 lb. of zinc, and 155,937 lb. of cadmium from 417,076 tons of ore mined and milled during 1958. The gross value of concentrates, less smelter charges, was $1,709,553 and other income was $11,099 from bank interest and $241 from other sources. Operating cost included $289,736 for transporting concentrates to smelter; $501,985 for mining; $386,835 for milling; $159,905 for other direct operating charges; $41,028 for administrative and general expense, and $14,918 for taxes. After the provision of $279,212 for depreciation and $41,000 for amortization of pre-production expense the net income for the year was $6,273. A reduction of almost $190,000 was suffered, despite the increased tonnage milled. Mr. Jensen, the company president, commented on March 31 :—

> During the first quarter of 1959, over-production of lead and zinc still continued and prices of both metals are averaging less than in the last quarter of 1958. At the time of writing this report, we have not been able to dispose of our stored zinc concentrate.

Lardeau. — Transcontinental Resources, Ltd., and Sunshine Lardeau Mines, Ltd., have purchased for cash the Teddy Glacier mine, disadvantageously situated at elevation 7,500 ft. but with a developed reserve estimated at 22,000 tons grading 0·25 oz. of gold and 7·0 oz. of silver per ton with 12% lead, 12% zinc, and 1% copper. The mine is only 15 miles from the Sunshine Lardeau mill and all but one mile of this distance is covered by good trucking road. A ropeway may be installed to cover the final mile. An effort will be made to achieve production this year.

TORONTO

April 24.

Gold Production.—During February the gold mines of Ontario milled 727,843 tons of ore and recovered 213,648 oz. of gold and 29,849 oz. of silver, valued at $7,317,564.

Geological Maps.—Preliminary geological maps of the townships of Carscallen, Jamieson, Mountjoy, Ogden, Turnbull, and Robb have been prepared by the Ontario Department of Mines from previously published geological and aeromagnetic maps, assessment work reports, and surface maps of individual properties. The base maps for plotting are taken from the Forest Resources Inventory sheets, Ontario Department of Lands and Forests, and are on a scale of 1,320 ft. to the inch. The geology was compiled by S. A. Ferguson.

Porcupine.—In 1958 McIntyre Porcupine Mines milled 802,270 tons of ore and recovered 228,948 oz. of gold and 41,473 oz. of silver. At the end of the year the ore reserves were estimated as 2,263,111 tons containing 711,691 oz. of gold. The report states: "During the year it was decided to initiate a complete review of the geological structure of the mine and its ore potentials. It is believed that a fresh look at McIntyre is appropriate at this time and a competent firm of consultants has been retained to guide this work." At Castle-Trethasey 16,956 tons of ore was crushed, sales amounting to 719,894 oz. of silver and 11,721 lb. of cobalt, while at Belleterre 103,529 tons was milled for 17,781 oz. of gold and 20,556 oz. of silver. The Belleterre operation is closing down. The consolidated accounts of McIntyre Porcupine show a net income of $2,316,774, of which $2,287,785 was required for dividends equal to $3·00 a share. A credit balance of $45,080,455 is carried forward.

During 1958 Dome Mines milled 707,900 tons of ore, the bullion output being valued at $5,962,970. Net earnings are given as $1,818,838.

Kirkland Lake.—Lake Shore Mines production for 1958 was valued at $2,396,001 from 288,763 tons of ore milled. After Emergency Gold Mining Assistance Act payments there was an operating profit of $238,214.

Saskatchewan.—The International Minerals and Chemical Corporation has abandoned the attempt to continue its shaft through the Blairmore sand by grouting. Since the 1,200-ft. level was reached progress has been practically nil and it has now been decided to continue through the formation by freezing. It has been stated that by the end of July the limestone would be reached and that thereafter progress to the potash horizon would be rapid.

Gunner Mines reports a profit of $11,219,558 for 1958, against $8,612,846 for the previous year. An expanded contract with Eldorado Mining and Refining has been arranged, it is reported.

Manitouwadge.—In the report for 1958 the ore reserves of Geco Mines are given as 16,011,200 tons assaying 1·79% copper and 3·71% zinc, with 16·81% of pyrite and 1·84 oz. of silver per ton.

Quebec.—The report of the Normetal Mining Corporation for 1958 shows a consolidated profit of $803,854 and $4,271,180 available in the accounts. Dividends equal to 15 cents a share required $563,551. At the mine 355,374 tons of ore was milled and 49,509 tons of copper concentrates, 21,078 tons of zinc concentrates, and 28,853 tons of pyrite produced. Ore reserves total 1,955,400 tons, averaging 3·54% copper and 5·05% zinc.

A progress report issued by the Quebec Ascot Copper Corporation on March 26 stated that the Corporation, which assumed stock control of R. M. Nickel Mines late in January, is conducting an intensive exploratory programme on the Beauchastel Township property, some 12 miles west of Noranda. Results to date indicate that this could be the next producer in the Noranda area, it is stated.

On April 19 Aluminium, Ltd., announced that an underwater explosion unique in hydro-electric construction, had blown a 30,000-ton rock plug at the Chute-des-Passer power project at Northern Quebec. The

plug, measuring 100 ft. by 50 ft., was $\frac{1}{8}$ mile under the Paeribonca River, 600 ft. upstream from the Passe Dangereuse storage dam, the entrance to a six-mile long supply tunnel leading to the underground power house at Chute-des-Passes. Power from the project is to consolidate the Aluminum Co. of Canada's power needs for its Saguenay district aluminium smelting operations and provide for additional smelter capacity. The cost of the project has been estimated at $150,000,000. By early 1960 Alcan's total installed generating capacity in the Saguenay district will be 3,600,000 h.p.

MELBOURNE

April 20.

Oil.—Interest in the search for oil in Australia and New Guinea continues at a high level. The Delhi-Santos-Frome group is now drilling at Innamincka, on the South Australia–Queensland border and progress has been rapid so far, the lowest formations being reported as shale with traces of black coal and plant fossils; the objective of this work is 14,000 ft. In Western Australia, West Australian Petroleum, Ltd., is continuing drilling at Meda, in the Kimberley country and several indications of oil have been reported from the hole now in progress but so far nothing in the nature of tangible encouragement. A second locality in the State which is under examination is Frome Rocks, also in the Kimberleys.

A newcomer in the search is the Australian Paper Manufacturers, which company, in view of the large enterprise developing in the Latrobe Valley, Victoria, has decided to contribute to the geological knowledge of that area, notable for the great brown-coal enterprise which has been expanding for a number of years and which is also a centre of paper making. The company has applied to the Department of National Development for approval of the proposed drilling operations. Subject to such approval and agreement as to the basis of subsidy, a stratigraphical bore-hole will be drilled on one of the areas held under licence. The company emphasizes that the work is intended to contribute to geological knowledge without immediate anticipation of finding oil.

A preliminary investigation of oil prospects in an area of country covering 177,000 sq. miles along the Great Australian Bight in Western Australia and South Australia is to be made by aerial survey. The area includes an extensive sedimentary basin and is held by the Australian company—Oil Drilling and Exploration.

An enterprise which is now showing tangible results is the exploration for natural gas in the neighbourhood of Sydney and Newcastle. Reports from the Camden locality in the Sydney area have indicated the occurrence of gas in probably large quantity and under increasing pressure. In the Newcastle district gas has been met in what may be commercial quantity but the extent here is much less definite than in the Camden prospect. Proving of adequate gas in either locality would be of very great importance as these are amongst the country's greatest industrial localities.

As a sequel to the location of flow oil at Puri, in New Guinea, one of the operating associated companies, Oil Search, Ltd., proposes to issue further capital which will provide £A2,835,000 for future operations. Australian interests took up areas and have carried out preliminary drilling in Timor, where attractive superficial indications existed. Upon exhaustion of capital work was suspended for a time. It has now been reported that Timor Oil, Ltd., has secured the financial assistance of Tradewinds Exploration, Inc., a United States company, to further drilling operations. An option has been arranged under which the Tradewinds organization will drill 15,000 ft. of hole free of cost to the Timor company.

New Zealand.—A detailed fact-finding survey directed to the possible early establishment on an iron and steel industry in New Zealand has been completed on behalf of Stewarts and Lloyds, Ltd., and Colvilles, Ltd. It is stated that these companies are to participate with Fletcher Holdings, Ltd., and Industrial Metals, Ltd., in the Pacific Steel, Ltd., mill at Otahuhu, the objective of which will be the production of 50,000 tons of steel per year from local scrap. The Government has approved of the scheme in principle but approval has not yet been given to any group or company to proceed with an integrated plant based on iron sands and local fuel and power. It is considered that the larger scheme will eventually come to fruition, but much more detailed work on iron sands will be necessary to determine conclusively the most satisfactory technical and economic process to be used.

The New Zealand Minister for Industries and Commerce has announced that an aluminium fabricating industry will be established in New Zealand by the Northern Aluminium Co., of England, and Canadian interests. The plant will be designed for the production of 5,000 tons of aluminium sheet and 2,000 tons of aluminium wire per year. There will be an initial investment of £NZ2,000,000. The plant will provide all New Zealand requirements of sheet and cable products with provision for expansion in all fields.

Australian Iron and Steel, Ltd.—Australian Iron and Steel, Ltd., which has works at Port Kembla, New South Wales, and uses iron ore from Cockatoo Island, Yampi Sound, Western Australia, in the report for the year ended November 30, 1958, advised that operations have been maintained at a high level of efficiency with an increased output of products. Two records were established by the production of 1,236,500 tons of pig iron and 1,342,500 tons of steel ingots. Production in ancillary departments was also the highest yet achieved. The company's South Coast collieries recorded an output of 1,687,000 tons of coal. The collieries have attained a high level in mechanization and efficiency. The net profit for the year was £A3,878,495, after providing £A4,668,698 for depreciation and £A2,750,000 for increased cost of plant replacement.

Raub Australian.—An Australian company—Raub Australian Gold Mining—has been engaged in gold mining for many years but its recent history has been one of great difficulty, covering a long period of rehabilitation of the plant destroyed during the war and the reconditioning of the mines themselves. In this period there have been labour troubles and strikes which have seriously retarded progress. This year operations have been normal and production and grade of ore are reported as satisfactory. Work is proceeding to bring more shafts back into production and planned additions to the milling circuit are nearing completion.

Northern Territory.—A report by the Minister for Territories states that despite the fall in metal prices for all minerals but gold the value of the Territory production continues at a high level. It is unlikely, however, that the value of production in 1958–59 will reach the record level of 1957–58, which totalled £A4,030,000, excluding uranium. There are, however, some prospects of developments which could lead to increases in production. The Government battery at Tennant Creek was re-opened in October and has been working at capacity on gold ore of good grade supplied by working parties and small groups and prospecting companies. This activity, it is hoped, will lead to a revival of small-scale mining at Tennant Creek, quite apart from the highly-productive operations of the Australian Development Company, which operates its own treatment plant and produces approximately 3,000 oz. of gold per month.

The Bureau of Mineral Resources has been drilling at the Maranboy tinfield to test the possibilities of the tin lodes at depth. A group of Australian companies hold options in this area and successful work by the Bureau could lead to substantial increase in production of tin. The Bureau has also been examining the Mount Harris region where two other companies are engaged. A very interesting discovery of lode tin was made there in 1958, but confirmatory work was stopped at the close of the year by the wet season and it has only recently been possible to resume testing work as the country at that season becomes impassable.

Western Australia.—Production of Western Australian minerals, inclusive of coal but excluding gold, in 1958 was £A6,500,000, according to figures issued by the Department of Mines. In the final quarter of the year the Collie coalfield produced 215,315 tons of coal valued at £A562,062, approximating one-third of the mineral wealth for the term. Asbestos was the second mineral in importance, 3,835 tons of fibre being worth £A353,819. Manganese increased and is now becoming of considerable importance in the State's mineral production. For a number of years reserves of manganese ore in Australia were a matter of concern and export was prohibited, but the position has so improved that export is now allowed and this has stimulated prospecting and the resulting discovery of occurrences of importance in Western Australia. In the last quarter of 1958 the State's production was 17,368 tons valued at £A214,904. In the period exports of iron ore from Yampi Sound to the steelworks in New South Wales totalled 136,751 tons and in the same time the Wundowie works, in Western Australia, treated 7,495 tons of ore for the production of 4,748 tons of pig iron valued at £A106,830. Proposals are being developed for the expansion of this undertaking which

was based on the utilization of small deposits of iron ore in the Darling Ranges.

Sulphur production from pyritic ore at Norseman and from auriferous concentrates from the Golden Mile mines at Kalgoorlie is growing in importance but suffers from the importation of brimstone. In the last quarter of 1958 sulphur amounted to 6,294 tons with a value of £A95,424. The Norseman pyrite is non-auriferous but the auriferous Golden Mile concentrate is treated at the purchasing acid works at Fremantle for recovery of the gold. The matter of encouraging the use of Australian pyrite and pyritic ores for acid manufacture is the subject of inquiry at the present time and the decision could mean substantial uplift to that side of the mining industry. Production of pyritic material is usually in the nature of by-product in the concentration of sulphide ores but Norseman Gold Mines, Western Australia, and Nairne Pyrites, in South Australia, are mining and concentrating clean pyrite unassociated with other sulphides or gold.

Gold.—The Commonwealth Statistics Bureau has announced that the production of gold in Australia in 1958 was 1,102,731 fine oz., which is the second highest output for any year since the war. Subsidies paid to gold producers by the Commonwealth Government in the year amounted to £A733,528, as compared to £A588,512 in 1957.

FEDERATION OF MALAYA

April 10.

Iron Ore.—It is reported that the Ipoh Mining Co., Ltd., has concluded an agreement with a group of Japanese steel mills to ship 170,000 tons of iron ore to Japan and that two members of the staff are to visit major iron and steel mills in that country. They are also looking into the possibilities for increasing exports of iron ore. There are at present three iron-ore companies operating in Ipoh and their total production amounts to about 500,000 tons annually; last year they exported 200,000 tons.

Japanese mills are said to be negotiating with other mining interests elsewhere in Malaya to step up purchases of iron ore to meet Japan's increasing iron and steel production. Steel manufacturers there have already contracted to buy ore from Malayan sources as follows: Dungun, 1,800,000 tons; Sri Medan, 400,000 tons, and Kepong, 40,000 tons. Figures show that in the first 11 months of 1958 Japanese purchases of iron ore totalled some 2,300,000 tons, as compared with 2,700,000 tons in the corresponding period of 1957. The total Malayan exports were 2,500,000 tons, a drop of nearly 300,000 tons on the 1957 amount.

Uranium in India.—Dr. H. J. Bhabha, secretary to the Department of Atomic Energy, said in Bangalore recently that the established reserves of uranium in India at present were more than 30,000 tons. Those of thorium were not less than 500,000 tons, to be found in the monazite sands in the west coast and to a larger extent in the newly-discovered area in Bihar.

Oil in Pakistan.—Pakistan produced more than 1,985,000 barrels of crude oil in 1958, recording an increase of about 58,830 barrels over the previous year. The oil refinery at Attock released 5,223 barrels per day of refined oil. Four exploratory wells at Kandhkot, Karachi, and Karsal in West Pakistan and one at Chhatak in East Pakistan, as well as a development well in the Sui gasfield, are scheduled to be completed to their projected depths this year.

Sarawak Bauxite.—About 100,000 tons of bauxite worth Malayan $1,837,000 approximately were exported by Sarawak last year and $151,000 was paid to the Government in royalty and export duty. Exports this year should be at least doubled and already at Sematan a stockpile of about 60,000 tons of ore is awaiting shipment after the monsoon has ended.

The bauxite occurs in undulating country, about half-a-mile from Sematan, westwards of Kuching. It forms a bed about 10 ft. thick under a thin cover of soil and is being worked by excavators, cleaned at a washing plant at Sematan, stockpiled, and then loaded on to steel lighters and taken to ocean freighters about three miles out at sea. Twelve freighters shipped ore from Sematan last year. Prospecting for further bauxite has begun again and testing at the margins of the Sematan deposit indicates that ore may extend beneath sands beyond the already known margins of the deposit.

The company mining the bauxite—Sematan Bauxite, Ltd.—intends to test possible extension this year and to examine further the possibilities of working a deposit at Bukit Gebong, about three-and-a-half miles away. This bauxite industry is yielding useful revenue and employment at good wages is provided, according to a Government statement. The workers are being trained in

the use of mechanical equipment and the area itself is being developed.

Oil.—A party of four geologists from the Philippines recently arrived in Kuching to tour the offices of the Geological Survey; they also are to visit Shell geologists in Seria.

A pipeline 160 miles long is to be constructed by Shell from its Tandjung oilfield in South Borneo to its refinery on the coast at Balikpapan. The pipeline and ancillary equipment should take three years to build and cost about £18,000,000; an additional £5,000,000 is to be spent on the further development of the oilfield. The 20-in. diameter line is to be laid later this year and when completed will have a capacity of 2,000,000 tons per annum.

The Tandjung oilfield, which was discovered in 1938, yields a highly paraffinic oil, the pumping of which involves many technical problems. These have been under examination for a number of years and in the new pipeline the oil will be mixed with about 30% of water and pumped in suspension.

Sumatra.—A Japanese team which visited North Sumatra, Indonesia, recently, has reported that the output of the Pangkalasus oilfield there could be increased from 20,000 tons to 120,000 tons monthly if the field's port and pipelines were improved. The cost of such improvements would be about £2,800,000, said a Japanese spokesman quoted in a Tokyo message. Details of the investigation were being sent to the Indonesian Government.

JOHANNESBURG

April 30.

Union Affairs.—In the first two months of 1959 and 1958 imports were valued at £78,500,000 and £104,800,000 respectively, the corresponding exports being £64,200,000 and £64,300,000, and gold sales £37,300,000 and £35,700,000. According to the economic and financial review by the South African Reserve Bank, the total income in 1957–58 increased to £1,988,000,000 from £1,931,000,000. While the monetary volume of economic activity increased further in 1958, the rate of increase from 1957 to 1958 was substantially lower than from 1956 to 1957, as the result of a decline in the second half of the 1958 year. This decline was associated with the more stringent monetary policy adopted earlier in the year and the substantial decline in the value of exports, which was indeed the principal factor in the adoption of the more stringent monetary measures mentioned, in order to arrest the easing tendency in the gold and exchange reserves. Those measures embraced the increased supplementary reserve requirements of the commercial banks; the curtailment of credit for direct and indirect financing of imports. The general slackening of business also contributed to the lower level of economic activity. As a result of reduced imports and the much improved inflow of capital, the gold and exchange reserves reflected a substantial rise, which continued in the opening months of 1959. In these same months the Bank Rate was reduced from 4½% to 4%; the commercial bank's lending rates were reduced by ½%, and the supplementary reserve requirements were further reduced from 6% to 4%.

Uranium Returns.—The figures in Table 1 show estimated revenue and cost figures for

Table 1

Current Uranium Production Figures

	Estimated Revenue (s.)		*Treatment Costs (s.)*
	Per lb. U_3O_8 sold	*Per ton milled*	*Per ton milled*
Loraine	84·42	18·67	9·25
Pres. Brand	87·06	16·69	7·65
Pres. Steyn	90·19	21·82	9·51
Welkom	89·21	20·15	8·36
Daggafontein	83·12	17·02	6·25
Vaal Reefs	77·95	46·51	11·67
Western Reefs	87.59	43.45	18·67
Afrikander Lease	79·48	83·78	38·46
Randfontein	96·59	—	—
East Champ	89·09	—	—
Freddies Cons.	82·06	26·9	10·4
Harmony	82·75	43·72	12·98
Blyvooruitzicht	82·69	40·7	15·01
Buffelsfontein	78·84	39·53	10·58
Stilfontein	83·74	18·59	7·3
Ellaton	88·72	30·03	17·06
West Rand Consolidated	73·61	37·17	4·46
Luipaards Vlei	83·72	44·37	5·51
Vogelstruisbult	110·6	20·92	9·6
West Driefontein	104·87	18·02	6·93
Doornfontein	102·94	9·98	6·59
Hartebeestfontein	76·0	77·12	17·43
Virginia	84·83	39·27	13·4
Dominion Reef	79·88	81·73	53·08

the uranium producing mines. West Rand Consolidated is well placed to compete in the uranium market after the expiry of its contract at the end of 1964. However, gold operations can at best be conducted on a very marginal rate of profit.

Transvaal.—West Driefontein, near its southern boundary in the high-grade southwestern section contiguous with the north-

eastern section of Western Deep Levels, obtained its first disclosures on the Ventersdorp Contact Reef horizon in the first quarter of 1959, 270 ft. being sampled and 150 ft. or 55·6% proving payable, averaging 11·3 dwt. over an estimated stoping width of 42 in. or 475 in.-dwt. Evidence of the probability of a marked falling-off in reef values eastwards was derived from a bore-hole drilled about 7,500 ft. east of No. 5 Shaft—namely, in the south-central section of the mine. The Ventersdorp Contact Reef was intersected at 4,560 ft. with values of 139 in.-dwt.; the Main Reef at 6,070 ft., 45 in.-dwt., and the Carbon Leader Reef at 6,246 ft., consisting of a number of carbon seams and small pebble conglomerate bands, 3·9 dwt. over 73·2 in., or 295 in.-dwt., core recovery being almost complete. The bore-hole is being deflected. The mine is sinking the winze on the Ventersdorp Contact horizon in the No. 5 Shaft area in the south-western section to cross the boundary into Western Deep Levels, in which lease area a drive westwards on reef will be advanced. The mine is also advancing exploratory development beyond the northern boundary in the north-western section contiguous with the Blyvooruitzicht property. Payable values backwards over the last three quarters have been: 629, 641, 667, compared with the 1957–58 average of 710 in.-dwt. The decline is associated with the extension of operations eastwards from Nos. 1, 2, and 3 shafts, the latter being in the north-central section, towards the No. 4 shaft area, where sinking proceeds or will be continued.

Western Deep Levels has now arranged with its northern neighbour—West Driefontein—for cutting a winze from the latter's No. 5 shaft workings down-dip on reef on the Ventersdorp Contact horizon. After this winze has crossed the common boundary a reef-drive westwards on strike will be advanced within the Western Deep Levels lease area. This will facilitate an earlier disclosure of values from the Ventersdorp Contact Reef. Available information is not adequate for anything like an accurate forecast of what values will be obtained. It is, however, possible that these values may be of the order of 252 to 378 in.-dwt.

At Buffelsfontein ore reserves at the end of June last averaged 9·55 dwt. over 57·9 in. or 553 in.-dwt. It is the expectation that as operations are extended underground development values will fluctuate. The bore-hole grade range for the lease area was 280 in.-dwt. to 400 in.-dwt. with a high percentage of payability, the indications being that the average values on reef developed would conform more to the upper limit. The mine is preparing to sink a sub-vertical shaft in the north-western section, which is at present served by a twin-shaft system. The gold plant capacity has been completed to 160,000 tons to 180,000 tons a month. Over the last two quarters the gold treatment rate was raised to 127,000 tons from 122,000 tons a month average.

Zandpan Gold Mining at an estimated cost or capital expenditure of about £7,100,000 will complete its No. 1 shaft in the south-central section, provide necessary services and facilities, and advance a certain footage of underground (including reef) development. Further capital will then be raised for sinking a second shaft system at an undisclosed site, which will be determined probably by drilling disclosures in the No. 1 shaft area, for the erection of a gold plant, and for providing housing, services, and other facilities to bring the mine to the initial stages of production. The layout of the No. 1 shaft has been modified. A circular 26-ft. diameter (inside-lining) unit, bratticed for upcast and downcast ventilation, it will be sunk as an unbroken vertical shaft from surface to the Vaal Reef horizon at a depth of about 7,000 ft. below surface. This will facilitate an earlier start of exploratory development than would have been the case, as originally intended, in sinking the shaft in two sections, as a vertical unit to a depth of about 5,000 ft. followed by a sub-vertical unit from about 5,000 ft. to about 7,500 ft. Excluding certain bore-hole results in the extreme eastern section, which were the subject of an inconclusive official investigation, the indicated bore-hole grade range for the lease area of 5,247 claims is 220 in.-dwt. to 260 in.-dwt. Including those eastern results the range is raised from 400 in.-dwt. to 600 in.-dwt.

Hartebeestfontein Gold Mining is drilling three more bore-holes to provide additional information that will facilitate planning the layout of the deeper section of the mine, which is served by two shaft-systems and will be served by another system still to be sunk in the south-central section.

Reef development so far conducted by Vaal Reefs in the western section has shown that the stratification conforms to an anti-cline with a north–south axis and that most

of the operations to date have been conducted in the shallower middle zone of the anticline. Development eastwards from the joint shaft system (used jointly with Western Reefs) has indicated a falling-off in grade from that exposed in the joint shaft area. Interest, therefore, attaches to the extension of operations further eastwards from the No. 1 shaft area into the central and deeper south-eastern section, particularly beyond the Kromdraai fault, and towards the site of the No. 2 shaft-system. In the No. 1 shaft area a second 300-ton refrigeration unit is being installed and additional underground fans are being provided to increase the ventilation-flow. The twin No. 2 shaft-system of a 26-ft. diameter main hoisting component (equipped with a concrete head-frame and a Koepe-winder with 14-ton skips) and a 20-ft. diameter ventilation component is to be sunk to a depth of 7,200 ft. The hoisting speed will be 3,600 f.p.m. The system will be commissioned in 1962. By that time the gold plant capacity will have been expanded to a rated capacity of 125,000 tons monthly and eventually to 150,000 tons from the present figure of 100,000 tons. The estimated capital expenditure of more than £5,600,000 will be provided from earnings without any adverse effect on dividends expected.

Dominion Reefs (Klerksdorp) in the first quarter of the current year commissioned a waste-sorting surface plant. As a result of this and possibly a higher-grade feed to the mill and treatment plants, the extraction improved to 1·058 lb. from 1·015 lb. U_3O_8 per ton treated. Reef development results improved to 72·7% payability averaging 72 in.-lb. from 68·7% averaging 68·06 in.-lb. in the previous quarter.

Winkelhaak Mines is feeding run-of-mine ore directly to 12-ft. diameter tube-mills in the mill and has eliminated coarse crushers from the circuit. This has resulted in a considerable reduction of labour in the mill, which is also equipped with electronic control systems.

A new company—Electrolytic Metal Corporation (Pty.), Ltd.—through an agreement with West Rand Consolidated has been conducting tests in a pilot-plant on the mine property for the electrolytic recovery of manganese from the uranium plant effluent. These tests have been economically successful and a full-scale plant is now being erected. The West Rand Consolidated company has acquired a 20% interest in the venture and is committed to support it further through loans.

East Champ d'Or previously reported that the life of the mine was almost entirely dependent on Bird Reef tonnage, which was not considered adequate for the term of the contract. However, more recently the Foot-Wall Reef was examined with unexpectedly satisfactory results despite lower percentage payability than disclosed on the Bird Reef horizon. Present indications are that Foot-Wall Reef tonnages will provide a useful addition to the mine's life as a uranium producer.

Orange Free State.—To the end of the first 1959 quarter Loraine Gold Mines sampled 3,295 ft. on the multi-banded reefs of the Elsburg Series in the south-western Loraine and in the extreme northern Riebeeck sections of its lease area, with average values of 330 in.-dwt. Drilling results from these reefs, which occur in the south-western Loraine section and the Riebeeck section immediately to the south of the former, indicated a grade range from 506 in.-dwt. to 782 in.-dwt. The Basal Reef, which is to be selectively exploited in the Loraine section only, had a bore-hole grade range from 150 in.-dwt. to 215 in.-dwt. The Riebeeck shaft, which had been sunk to 3,735 ft. by the end of March, is now in Elsburg formations. Reefs in this Series should be intersected in the near future. The shaft is expected to be completed to its final depth above the Basal Reef horizon about the mid-year or shortly thereafter, probably by December. Stoping of Elsburg ore is not expected to be initiated much before the year-end. Water has been encountered in one of the two levels advanced from the Loraine workings to the Elsburg horizon and this water-zone is expected to be traversed by the second level drive or haulage. Pumping capacity is being increased at the southern Loraine shaft and will be provided in the Riebeeck Shaft. The mine has classified the multi-banded Elsburg Reefs into four zones, in the upper of which development has so far mainly been confined—in the northern Riebeeck section and south-western Loraine section.

Harmony Gold Mining which about last mid-year contracted to sell 1,500 tons of U_3O_8 to the United Kingdom Atomic Energy Authority additional to that contracted to the Combined Development Agency, increased its output of the oxide from 111,360 lb. in the second 1958 quarter, to 132,760 lb., 158,440 lb., and 174,990 lb., respectively, in the third and fourth 1958 quarters and the

first 1959 quarter. In the last two quarters mentioned sales of the oxide advanced from 158,440 lb. to 173,750 lb.

President Brand has now completed sinking the twin No. 2 sub-vertical shaft-system with the sinking of the main component to its final depth. The final stages of equipping are in progress. The northern workings, where operations are likely to be extended, have been connected with the joint No. 3 shaft-system in the Welkom lease area for ventilation purposes. Sinking of the new President Brand No. 3 twin shaft-system proceeds in its early stages.

Central African Federation.—Following unconfirmed rumours of the disclosure of indications that the gold-producing potential of the Rhodesias may be greater than previously envisaged, it has been reported that the recently-appointed consulting geologist—Dr. H. Gunning—in the Salisbury office of the Anglo American Corporation has referred to the great possibility of finding gold in the territories in large quantities. He considered, however, that in respect of gold the days of the small worker were over.

Rand Mines has exposed encouraging indications of copper deposits in preliminary prospecting in the Kario area of Southern Rhodesia and has applied for exclusive prospecting grants over an area of 500 sq. miles. More detailed investigation is planned.

Trade Notes

Brief descriptions of developments of interest to the mining engineer.

Front End Shovel

An addition to their range loading equipment has recently been announced by **Merton Engineering Co., Ltd.,** of Faggs Road, Feltham, Middx. This is the Frontloader 59 illustrated here. As will be seen a feature is the location of the driver's cab at the very front of the machine, giving the driver all-round visibility and an unobstructed view of the bucket and the ground to his front. Particular attention has been paid to maintenance requirements, all points requiring daily, weekly, or periodic attention being immediately accessible, and, should major engine or hydraulic repairs become necessary, one man can, in five minutes, remove all the necessary covers and exterior sheeting by hand. The hydraulic pump is readily accessible and can be removed without disturbing the radiator.

The hydraulic linkage gives a loading height (under the lip of the tipped bucket) of 10 ft. 6 in. or 12 ft. under the hinge pin. At this maximum discharge height there is a forward reach of 2 ft. The standard bucket covers the full width over the front wheels and is of 1 cu. yd. capacity. The payload is 2,800 lb. and smaller or larger capacity buckets are available for very heavy or light materials. The bucket crowd angle is 45° and the discharge angle at maximum height is 45° permitting excellent discharge of sticky materials. The machine is powered by the new Fordson 4 cylinder, 4 stroke engine giving 54 b.h.p. at 1,800 r.p.m., the drive being transmitted to the rear wheels through a 13 in. Borg and Beck extra heavy duty clutch (with provision for external lubrication) and a transmission which gives 6 forward and 2 reverse speeds, up to 12·45 m.p.h. and 4·75 m.p.h. respectively.

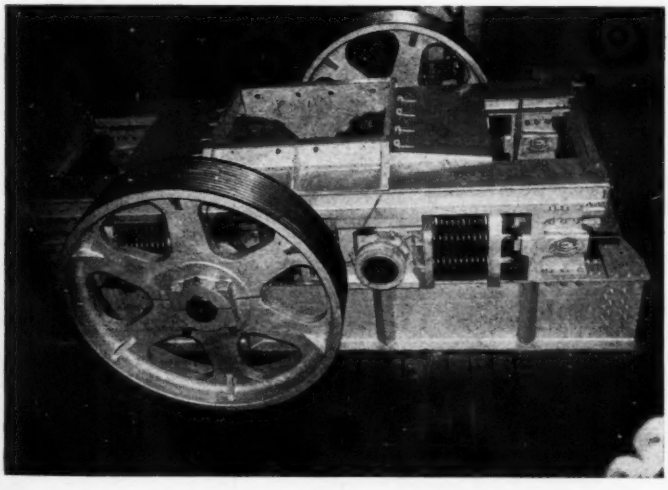
Double Slugger-Roll Crusher

A double-roll crusher with manganese-steel shells of special design capable of handling wet or sticky materials now being manufactured in this country by the **Babbitless Co. (Great Britain), Ltd.,** of 123, Victoria Street, London, S.W. 1. The roll shells incorporated in this "Double Slugger-Roll Crusher" have, in addition to standard teeth, a series of longer teeth or "sluggers," which nip and shear the larger lumps, forcing them down into the machine

Merton Front-End Shovel.

while the ordinary teeth complete the crushing process. The makers claim a very rugged and heavy construction and state that this machine can deal with tough material, the frames being of cast steel and heavy sections to withstand the most arduous operating conditions. The rolls are individually driven at the same speed while the bearings of each roll are mounted on a nest of very strong springs which enable an emergency opening of the rolls when large pieces of tramp iron or any uncrushable material passes through the crusher. Adjustment of the rolls is simple and the machines are grease lubricated by means of a central system synchronized with the main drive. Figures available show the power required is low while the tonnage output is high.

Low wear of the shells is claimed and a machine of this type has crushed 14,000,000 tons of Lorraine iron ore to date without replacement of any wearing parts. The crusher can be fed with run-of-mine ores, experience having shown that this does not affect capacity, which lowers the cost of the feeding arrangements considerably. Although these crushers are mainly used for a primary work, the teeth arrangement on the shells can be modified to suit a secondary duty. The machine is recommended for sticky ores, limestone, gypsum, marl, bauxite, or the clayey overburden found in open-cast mining.



Roll Crusher.

20-Ton Mobile Crane

Early last month, at their Letchworth works, **K and L Steelfounders and Engineers, Ltd.,** demonstrated their new KL 12–20M mobile crane, the first of a new series of three 20-ton capacity machines to go into production. The other two are the KL 12–20L, lorry-mounted, and the KL 12–20R—a rail crane. These new cranes are of completely new design although many of the successful features incorporated into previous models have been retained. In particular the direct diesel-mechanical transmission system common to all machines in the range remains, while the general arrangement on the slewing superstructure follows the established Jones practice of unit construction also. On British Standard ratings the crane lifts 20 tons with outriggers extended or 12 tons free-on-wheels, in both cases at 10-ft. radius. The standard jib is 30 ft. long.

The KL 12–20M chassis is mounted on 14 in. by 24 in. heavy-duty pneumatic tyres fitted in restrictor wheels, which not only restrict the deflection of the tyres but also protect the side walls from damage and give extra bearing area if the crane is working on soft ground. Two-wheel drive is the standard arrangement, but four-wheel drive is available as an alternative if required. A differential of automotive type is fitted, provided with a locking arrangement to prevent wheel spin on greasy surfaces, and all four wheels are fitted with powerful brakes capable of holding the machine on a 1 in 5 gradient. For travelling duties the brakes are hydraulically operated with air pressure assistance; in addition a hand lever with mechanical linkage is provided for parking purposes. Steering is hydraulic, a double-acting ram being fitted to actuate the track rod, so that little effort is required by the driver and it is possible to steer even when the crane is stationary. The KL 12–20 is also fitted with a special gear which enables the outriggers to be wound in and out with little effort and in quick time; the operation of

KL Mobile Crane.

extending the outriggers and positioning the screw jacks is a matter of seconds. To meet the demand for higher travelling speeds, particularly in certain overseas markets, this crane has been designed to travel at 8 m.p.h. unloaded, but when carrying full load the maximum recommended travelling speed is 2 m.p.h. Unloaded the crane will negotiate gradients up to 1 in 5.

Working on a single fall of rope the crane will lift 3½-ton loads at 120 ft. per minute, while the maximum load of 20 tons is lifted on a 6-fall block at speeds up to 20 ft. a minute. Loads up to 7 tons can be handled on 2 falls at speeds up to 60 ft. a minute and for lighter loads up to 3½ tons the single rope can be used giving hoisting speeds up to 120 ft. per minute. Derricking of the jib is obtained through 6 falls of rope, the grooved rope-drum being driven by totally enclosed worm gearing and a powerful automatic brake is fitted.

The standard power unit is the Perkins "FOUR 270D" diesel engine developing 62·5 b.h.p.; 12-V electric starting equipment is fitted and cooling is thermostatically controlled. The engine and machinery are enclosed in a weatherproof sheet steel housing with ample ventilation and access doors to facilitate running adjustments and inspection. The driver's cabin, which is separated from the machinery housing, is weatherproof, airy, and gives good visibility all round through windows glazed with safety glass. All the controls are conveniently arranged, the hand controls in regular use being located in a control desk in front of the driver.

Personal

V. J. ALBORNO is now in Ghana.

Dr. G. L. J. BAILEY has been appointed Superintendent of the Development and Research Department Laboratory of The Mond Nickel Co., Ltd., in Birmingham.

Dr. W. BETTERIDGE has been appointed Superintendent of the Platinum Metals Research Laboratory of the Development and Research Department, The Mond Nickel Co., Ltd., Acton.

J. V. BRAMLEY is leaving for Nyasaland.

H. F. BROWN is now in Ghana.

J. T. CHAPPEL has been appointed a director of Gopeng Consolidated.

P. P. EDWARDS is home from India.

R. H. L. EGERTON is now in Cyprus.

G. FINLAYSON is visiting the Argentine.

V. GOODWIN has left for Australia.

V. T. HOCKIN has retired as Commissioner for Mines, Tanganyika. He is to be succeeded by W. D. HARVERSON, formerly Commissioner of Mines and Geology for the Kenya Government.

A. HOLMES, Professor Emeritus of Geology at the University of Edinburgh, has been elected a Fellow of the Imperial College.

H. A. LAVERS is home from Tanganyika.

T. H. B. LAWTHER is home from British Guiana.

D. L. MARRIOTT is home from Kenya.

H. D. OSBORN is home from Malaya.

L. B. PFEIL, Director of the Development and Research Department of the Mond Nickel Co., has been elected a Fellow of the Imperial College.

D. P. H. ROWE is returning from Bombay.

J. H. SINCLAIR, at present assistant manager at Chibuluma Mines, Ltd., has been appointed the first Joint Secretary to the Mining Employers' Committee of the Joint Industrial Council in Northern Rhodesia.

Dr. W. STEVEN, Superintendent of the Development and Research Department Laboratory of The Mond Nickel Co., Ltd., in Birmingham, is being transferred to the Development and Research Division of the International Nickel Co., Inc., New York, as Director of Research. He has also been elected an Assistant Vice-President of that Company.

G. W. TOWERS is now in South Africa.

W. S. TRYTHALL is returning from Sierra Leone.

P. VISWANATHAN is now with the Department of Atomic Energy in Southern India.

F. G. VOGWILL is now in Ghana.

P. WESTERBERG is home from a visit to East Africa.

F. A. WILLIAMS is home from Nigeria.

Sir WILLIAM LARKE, who died on April 29, aged 84, was for many years director of the National Federation of Iron and Steel Manufacturers. When war broke out in 1939 he was made chairman of the Advisory Committee on Non-Ferrous Minerals at the Ministry of Supply and later, early in 1942, appointed Controller of Non-Ferrous Mineral Development, a post he held until the conclusion of hostilities. He was then elected vice-president of the Iron and Steel Institute and in 1947 was awarded its Bessemer Medal. Sir William, who had been president of the Junior Institution of Engineers and of the Institute of Fuel, had been a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. He had also been president of the Institute of Welding and of the British Standards Institution. He was a Member of the Institution of Electrical Engineers, a Fellow of the Institute of Fuel, and a member of the Institution of Mechanical Engineers as well as an honorary Doctor of Science of the University of Durham. Made O.B.E. in 1917, he was appointed C.B.E. in 1920 and later made K.B.E.

INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—William James TOUGH, B.A.Sc. (*Ottawa*).

Associate Member to Member.—John ASTRUP, A.C.S.M. (*Palermo*); Guiseppe BELLAVITA, D.Ing. (*Montevecchio*); George Peter BENNETT, A.C.S.M. (*Johannesburg*); Smith BRACEWELL, B.Sc., A.R.C.S., D.I.C. (*London*); Maurice James CAHALAN, B.Sc. (*London*); Bernard DAVEY, A.C.S.M. (*Wankie*); Eric Benjamin DAVIES, A.C.S.M. (*Malxim Nawar,*

Malaya) ; Raymond Curtis HOWARD-GOLDSMITH, A.R.S.M., B.Sc. (*Lima*) ; John Ernest METCALFE, Dip. Min. (*Plumtree*) ; James Edward Anthony PATERSON, A.R.S.M. (*Paagoumene, New Caledonia*) ; Ian Graham PERT, A.R.S.M., B.Sc. (*Geita*) ; Dennis Frederick REEVES, A.R.S.M., B.Sc. (*Jos*) ; Geoffrey Victor STANDERLINE, B.Eng. (*Hengoed*).

Associate Member.—Christopher Jobson BALLENDEN, B.Sc. (*Bancroft*) ; John Kenneth BEAN, B.Sc. (*Kitwe*) ; Colin Gibson BELSHAW, B.Eng. (*Bancroft*) ; William Neil BLANEY, A.C.S.M. (*Noranda*) ; Irving GAWTHROPE, B.Sc. (*Manchester*) ; Donald Hugh MCKERROW, M.M., B.Sc. (*Johannesburg*) ; Ian Alastair MENZIES, Ph.D. (*St. Annes-on-Sea*) ; William Alexander MILLIKEN, B.Sc. (*Edinburgh*).

Student to Associate Member.—William Michael Francis BOX (*Kumasi*) ; David John Ifor EVANS, A.R.S.M., Ph.D., D.I.C. (*Fort Saskatchewan*) ; Meshach Otokiti FEYIDE, A.C.S.M. (*Jos*) ; Arthur Conrad FITZGERALD, A.C.S.M. (*Barakin Ladi*) ; Michael David FULWELL, A.R.S.M., B.Sc. (*North Ferriby*) ; Peter Douglas HARMER, B.Sc. (*Hassocks*) ; Brian MOORE (*Carletonville, Transvaal*) ; Brian Hugh O'NEILL, A.C.S.M. (*Bukuru*) ; Edward John PERRY, A.C.S.M. (*Tilt Cove*) ; Dennis John Cooper SMALL (*Dartford*) ; John Somerville TOOMS, Ph.D., D.I.C. (*London*) ; George Tombling WHINCUP, B.Sc. (*Maryport*) ; Clifford Douglas WILLIAMS (*Mount Isa*).

Affiliate.—Harold James CAVE (*Camborne*) ; Chin Cheong TAN (*Batu Pahat*) ; John William HART (*Polis, Cyprus*).

Student.—Alan Geoffrey BLENKINSOP (*Johannesburg*) ; Richard Kenneth DUNHAM (*Leeds*) ; Kenneth Ralph HULTZER (*Johannesburg*) ; Tajammal HUSSAIN (*Lahore*) ; Ernest John JUDE (*Wickford*) ; Visco Vincent JUTRONICH (*Camborne*) ; Lionel Roderick MOORE (*Birmingham*) ; Suresh Madhav NAIK, B.Sc. (*Camborne*) ; Giles Martin Bailey NIXON (*Camborne*) ; Christian Peter PEDERSEN, B.Sc. (*Kitwe*) ; Dina Nath SINGH, B.Sc. (*Camborne*) ; Christiaan Petrus SMIT (*Johannesburg*) ; Brian John TARRY (*Grappenhall*) ; Petrus Jacobus Jansen VAN VUUREN (*Johannesburg*).

Metal Markets

During April [1]

Copper.—The copper market [2] has been disrupted and led astray in April by a rumour—well enough founded in the first place—that the U.S. Government proposed to release metal from part of its strategic holdings. It is by now well known that releases from the proper defence stockpile cannot be made without Presidential authorization and that this is not given except in cases of extreme stringency, which certainly do not exist at present. However, a heavy volume of metal is held in the "supplemental" stockpile and it was from this source that it was feared that up to 128,000 tons of metal might be released. Various reassuring noises were made in official American quarters—including a promise that the maximum rate of any releases would not exceed 5,000 tons a month.

It was, however, a few days before a categorical assurance was given that no such release of copper would be permitted and in the meantime copper sentiment had taken a sharp body-blow. As a result it was not surprising that on April 30 the U.S. custom smelters had to retreat somewhat from their level of 32·5 cents per lb. to 32 cents, although even at this level they remain dearer than the main producers. Matters were not improved in London by the fact that at the psychological moment that copper was most depressed persistent and influential selling emerged from one quarter, believed influenced by producers.

Statistics relating to the U.S. fabricating industry in March show a promising picture, with stocks of copper held down and deliveries of products and unfilled orders (especially the latter) up. However, even these figures, coming on top of the background fears of a strike at mines and smelters in the U.S.A. in the summer, do not seem able to lift the market altogether clear of the clouded atmosphere in which it has been languishing for so long past. Europe is obviously missing its wire business with Russia and consumer buying here is certainly not big enough to keep a smile on the market's face. Although a substantial American strike would inevitably force the market up, it is possible to doubt whether a shorter stoppage would have any serious effect. A good deal will, of course, depend on the progress of negotiations in this direction, which may be expected to start in perhaps a fortnight's time.

Copper consumption in the U.K. in February was 48,293 tons, of which 35,775 tons was refined copper. Production here included 8,224 tons primary refined and 7,780 secondary refined. During the month stocks generally rose, although blister fell from the revised level of 9,971 tons to 9,775 tons. Refined stocks moved from 50,827 tons to 56,100 tons.

Tin.—During the early part of April, which was, of course, the beginning of a new International Tin Agreement export control period, it was encouraging to note that Malayan and other eastern miners exercised more restraint than has been their habit at the commencement of other control periods, with the result that prices [1] have been able to remain ensconced in the low '80s for all but one day in April. Buying from the U.S.A. has continued a feature of the market during the month, notably from the tinplate makers, who are experiencing a strong recovery in their business at the moment. In the U.K. tinplate is also better, both on the home and export fronts, although not to the same extent as in America. Whether the better tone the other side of the Atlantic is due to fears of a possible shortage of supplies later, when a steel strike is feared, it is hard to say, but it will certainly hit tin hard if there is a protracted steel strike in America in July and the production of tinplate is interrupted by a shortage of steel sheets. In the latter days of April it was learned that both the U.S. and Bolivian authorities had approved a barter deal for 5,000 tons of Bolivian tin. This can presumably be effected without affecting Bolivia's quotas, but a more germane question, in view of what has been heard of the continuing labour troubles in Bolivia, is whether this quantity of metal is readily available without drawing on current production.

Tin consumption in the U.K. in February was 1,614 tons and production 1,677 tons, a low figure. Stocks declined to 14,175 tons.

Lead.—For some time past contemplation of the lead and zinc markets [1] has come to something of a

[1] Recent Prices, pp. 264, 300.
[2] See Table, p. 300.

[1] See Table, p. 300.

dead end at the end of April, in view of the major possibilities that exist for important decisions to be taken at the meeting under United Nations auspices to consider means of stabilizing lead and zinc markets. The fact that the chances of concerted action being taken are considered very small and that previous meetings have got nowhere does not lessen the size of the potential significance, so that the market is simply marking time until the results of the latest meeting are known—which may be expected very shortly after this report is completed. Interim reports that agreement has been reached on a system of voluntary global output reductions are viewed with considerable scepticism, but help to keep the meeting, and its object, in the public gaze.

Lead output in the U.K. in February was 6,150 tons and consumption 25,968 tons. Stocks went down to 43,542 tons.

Zinc.—Like lead, zinc is marking time [1] pending confirmation of market suspicions that the stabilization meeting now being held in New York will eventually yield no concrete results. Zinc is less affected than lead by the question of whether U.S. interests will manage to close what they regard as a "loophole" in the protection afforded them by the import quotas—namely, the opportunity for products in the two metals to enter the country subject only to a tariff barrier. Meanwhile, some countries filled their lead and/or zinc quotas for the second quarter on April 1, but the big-tonnage quotas are filling up only a little ahead of schedule.

U.K. February zinc consumption was 25,676 tons, production 5,542 tons, and stocks rose to 36,850 tons.

Iron and Steel.—The steel industry is slowly emerging from the trough of depression in which it has been wallowing for the past year or so. That brighter periods lie ahead is confidently expected by many in the industry, but the time it will take for a general recovery in operations is not clear at this stage. Actions taken by the Government to stimulate the economy are expected to result in expansion of industrial production, but the wide divergence of the steel industry's customers is such that increases in the rate of demand will be uneven.

On the question of the outlook for the U.K. steel industry, the British Iron and Steel Federation said in its recently-published annual report for 1958 that the prospects for the 12 months ahead were more encouraging. The run-down of consumers' and merchants' stocks, which, said the Federation, aggravated the industry's difficulties in the home market in 1958, was essentially healthy and would ease with the return of business confidence.

Meanwhile actual production is gradually recovering, although it is substantially below the level of capacity. The car industry continues to absorb large tonnages of steel, particularly strip-mill sheets. The U.K. tinplate trade is also buoyant and sales in both home and export markets are at a very good level, while consumers of other light-steel products are showing more interest in obtaining supplies.

The level of British exports continues below that of a year ago. In the first quarter of 1959 shipments declined to 635,344 tons from 681,998 tons in the corresponding period of 1958. Despite the decline in demand for steel in overseas markets it is encouraging to note that in 1958 the U.K. industry retained its share of the world market.

Iron Ore.—The continued low level of pig-iron output is still having an adverse effect upon iron ore. Moreover, steelmakers have increased their consumption of scrap; in the first quarter of 1959 the ratio between scrap and pig iron averaged 53·8 to 54·2 a week, as compared with the weekly average of 53·0 to 55·4 in 1958. Domestic iron-ore production is still running at a reduced rate, while imports of foreign ores fell to 2,780,000 tons in the first quarter of this year from 3,340,000 tons in the same quarter of last year.

Aluminium.—One of the interesting developments in aluminium in April actually relates to February. U.K. statistics of aluminium-ingot arrivals for February were only released during April and show two interesting features. One is that the largest supplier to this country in that month was, remarkably enough, the U.S.A. and the other is that, at over 1,700 tons, arrivals of Russian aluminium were the largest since September, 1958. It should be explained that the heavy American arrivals which put that country at the head of the list coincided with seasonally-low arrivals from Canada, which is, of course, normally far and away the biggest supplier here. Nevertheless, American arrivals are a sign of the times and may be considered as having perhaps some connexion with the acquisition by the Reynolds T.I. Group of British Aluminium. The Russian arrivals will, of course, need to be studied over a longer period before they can be said to have any noticeable significance, but it was remarked that, in the months following Russia's guarantee last September to limit exports here in the ensuing 12 months to 15,000 tons, actual arrivals remained at a negligible level. The February arrivals, which have an average statistical value of £170 a ton, revert to the rate in evidence in the corresponding period of 1958. In the U.K. Canadian metal remains priced at £180 a ton.

Antimony.—The antimony market remains very dull and there does not seem to be any great improvement in the export market for the metal and its products. It is, therefore, no surprise that U.K.-produced regulus of 99·6% purity remains quoted at £197 10s. delivered.

Arsenic.—Arsenic has remained a thoroughly uninteresting market during April and the U.K. home price continues at £400 a ton.

Bismuth.—Bismuth has remained an unexciting metal during April and ore and metal sales have been confined to routine. The U.K. price is still 16s. a lb.

Cobalt.—One of these days the endeavours of the Centre d'Information du Cobalt may come up with a radically new use for the metal. However, such would probably have to almost double current consumption to make a significant impact on the market, which in the U.K. remains at 14s. per lb.

Cadmium.—Following last month's price change cadmium has not exhibited any new features from the market point of view, although it is pleasant to note that U.K. consumption continues to sustain a good trend. Even at present prices there is still more than enough metal available. In the U.K. cadmium is 9s. per lb.

Chromium.—Chromium-metal business in this country continues completely routine at prices between 6s. 11d. to 7s. 4d., but export business continues to be of interest in an erratic way.

Tantalum.—Although the long-range outlook for tantalum in its specialized applications remains a cause for modest confidence, world demand at present is not as great as the level of offerings and the prices quoted by serious buyers have shown a further decline. The market is now indicated at 550s. to 600s. per unit, on a nominal basis.

Platinum.—The platinum market has seen one of its quiet intervals in April, not only major sellers' price, but also that of imported platinum having remained unchanged throughout the month, the former at £28 10s. an oz. and the latter at about £27 an oz. Perhaps by the end of the year it will be possible to discern first indications of the better outlook which has been promised for platinum, but so far this is not easy.

Iridium.—Iridium, too, has remained stable in price in April and continues at £24 to £24 15s. nominal per oz.

Palladium.—Palladium trade has followed the usual course during April and the market prices have remained quite steady at £7 5s. an oz.

Osmium.—The prices indicated last month for osmium—£23 to £32 5s.—have continued effective during the greater part of April, but the market has remained stagnant.

Tellurium.—There has been no significant change in either the production or consumption of tellurium on a global basis and in the U.K. the price remains 15s. to 16s. per lb.

Tungsten.—April has been featured by a gradually-growing strength in the tungsten-ore market and on the last day of the month prices were advanced for the first time in almost ten weeks and now stand at 87s. to 92s. per unit of WO_3. Although a number of background factors have contributed to the progressive strengthening of the market's tone, it is doubtful whether an increase in price could have been generated without the influence on the market of a substantial order for ore to meet a demand for tungsten carbide for German defence purposes. This being a discontinuous type of inquiry it remains to be seen whether the better tone generated will be maintained or whether the ready availability of ore supplies, notably from behind the Iron Curtain, will gradually replenish stocks and again depress the market.

Nickel.—The annual report of the International Nickel Company of Canada, released on April 29, continues to foreshadow a world nickel surplus for many years. This is regarded as a good thing, however, as it should give consumers an assurance of supplies which they have not had for some time past. In the U.K. prices are rigidly held at £600 a ton.

Chrome Ore.—Chrome-ore markets have been much the same as for some months past. During April the only news of any significance was that of a barter deal which was thought possible between Transvaal and America, but this now looks as though it may take some considerable time to consummate. In the U.K. Rhodesian material may still be valued at £15 15s. per ton for metallurgical ore.

Molybdenum.—There is little new that can be said of molybdenum, the price remaining unchanged at 8s. 11d. per lb. of metal f.o.b.

Manganese Ore.—Certain reports that a substantial barter deal between India and the U.S.A. might be concluded during April seem premature, as were other reports on the same deal over the last 15 months. Perhaps the deal will be concluded by the autumn. The market in the U.K. remains nominally quotable at 70d. per unit for 46% to 48% ore.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75% ; Copper, electro ; Lead, minimum 99·75% ; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Apr. 10	780 10	782 15	242 12½	242 12½	68 3¾	69 8¾	71 11¼	71 6¼
13	779 0	780 0	239 7½	239 7½	67 18¾	69 8¾	71 13¾	71 6¼
14	780 10	782 5	238 2½	238 2½	68 8¾	69 17½	71 13¾	71 7½
15	783 0	783 15	236 17½	236 17½	67 17½	69 12½	71 11¼	71 11¼
16	782 0	782 10	229 12½	229 17½	67 15	69 12½	71 11¼	71 8¾
17	782 10	783 15	234 10	234 15	68 6¼	69 15	72 2½	71 17½
20	784 0	784 15	233 17½	234 7½	69 7½	70 18¾	73 2½	72 17½
21	784 0	784 15	236 12½	237 7½	69 16¼	71 7½	73 12½	73 6¼
22	784 0	784 5	238 17½	239 7½	69 17½	71 6¼	74 2½	73 16¼
23	783 0	783 5	235 17½	236 12½	70 6¼	71 17½	73 18¾	73 11¼
24	782 0	782 5	234 2½	234 17½	70 8¾	71 18¾	74 6¼	74 2½
27	784 10	784 5	235 17½	236 12½	70 13¾	72 1¼	75 2½	74 12½
28	784 0	784 5	235 17½	236 17½	70 11¼	71 18¾	74 7½	73 17½
29	783 10	784 0	233 10	234 10	70 2½	71 3¾	73 18¾	73 16¼
30	784 0	784 5	234 12½	235 12½	69 8¾	70 11¼	74 3¼	73 16¼
May 1	784 10	784 0	233 7½	234 7½	69 7½	70 12½	73 15	73 8¾
4	783 10	783 15	232 7½	233 17½	70 5	71 2¼	74 15	74 7½
5	784 0	784 5	230 7½	232 2½	70 13¾	71 16¼	75 5	74 12½
6	784 0	784 5	232 7½	233 17½	71 3¾	72 3¾	76 7½	75 7½
7	784 0	784 15	233 17½	235 7½	70 13¾	71 16¼	75 15	74 12½
8	783 10	782 18	230 12½	232 7½	70 2½	71 6¼	76 2½	74 13¾
9	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	March		April	
	Treated Tons.	Yield Oz.†	Treated Tons.	Yield Oz.*
Blyvooruitzicht	120,000	77,520	126,000	80,338
Brakpan	141,000	17,000	136,000	16,976
Buffelsfontein‡	134,000	47,069	137,000	49,078
City Deep	114,000	23,950	113,000	23,823
Cons. Main Reef	125,000	20,419	120,000	20,713
Crown Mines	220,000	34,149	219,000	35,511
Daggafontein	242,000	49,352	244,000	49,373
Doornfontein‡	90,000	37,125	92,000	37,881
D'rb'n Roodeport Deep	184,000	34,136	188,000	35,069
East Champ D'Or‡	12,000	296	12,000	219
East Daggafontein	100,500	16,694	101,500	16,853
East Geduld	130,000	39,652	138,000	41,412
East Rand P.M.	221,000	56,906	223,000	59,069
Eastern Transvaal Consol	18,900	6,210	19,000	6,164
Ellaton‡	31,000	7,318	31,500	7,348
Freddies Consol.	56,000	14,173	58,000	14,249
Free State Geduld	79,000	61,764	82,500	64,752
Geduld	68,000	13,029	73,000	13,590
Government G.M. Areas‡	50,000	10,592	52,000	10,783
Grootvlei Proprietary	200,000	42,394	205,000	43,352
Harmony Gold Mining	115,000	45,732	125,000	49,185
Hartebeestfontein‡	87,000	46,980	88,000	47,960
Libanon	100,000	23,957	101,000	24,104
Loraine	75,000	14,625	78,000	15,210
Luipaards Vlei‡	123,000	14,100	125,000	14,289
Marievale Consolidated	92,000	22,978	93,000	22,968
Merriespruit‡	—	—	—	—
Modderfontein East	128,000	13,210	135,000	13,520
New Kleinfontein	83,000	10,898	84,000	11,012
New Klerksdorp‡	10,800	1,143	9,700	971
President Brand	100,000	77,504	107,000	86,670
President Steyn	99,000	38,330	105,000	40,473
Rand Leases	188,000	28,294	188,000	28,294
Randfontein‡	196,000	14,744	190,000	13,997
Rietfontein Consolid't'd.	16,000	4,132	16,000	4,134
Robinson Deep	66,000	13,700	57,500	12,368
Rose Deep	43,000	5,377	40,000	5,027
St. Helena Gold Mines	140,000	42,062	150,000	44,991
Simmer and Jack	84,000	15,316	91,000	16,247
S. African Land and Ex.	93,000	19,577	97,000	20,371
S. Roodepoort M.R.	29,000	6,979	30,000	7,209
Spaarwater Gold	10,700	3,395	11,000	3,556
Springs	104,000	14,286	105,000	14,280
Stilfontein Gold Mining‡	135,000	67,357	143,000	69,926
Sub Nigel	66,500	15,874	66,500	15,830
Transvaal G.M. Estates	6,800	1,983	6,200	1,873
Vaal Reefs‡	83,000	37,682	87,500	39,594
Van Dyk Consolidated	76,000	14,361	79,000	14,592
Venterspost Gold	130,000	32,253	130,000	31,857
Village Main Reef	26,500	4,780	25,000	4,632
Virginia O.F.S.‡	122,000	30,701	127,000	31,433
Vlakfontein	50,000	17,939	51,000	18,358
Vogelstruisbult‡	96,000	21,534	96,000	21,203
Welkom Gold Mining	95,000	29,230	100,000	30,629
West Driefontein‡	90,000	82,806	92,000	84,654
West Rand Consol.‡	214,000	21,740	211,000	21,081
Western Holdings	107,000	64,200	117,000	70,770
Western Reefs	121,000	31,460	131,000	34,062
Winkelhaak	69,000	16,794	74,000	18,197
Witwatersrand Nigel	18,100	4,366	18,200	4,390

† 248s. 9d. * 249s. 9d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Mar., 1958	15,806,300	64 10	46 6	18 4	23,170,987
April	—	—	—	—	—
May	—	—	—	—	—
June*	16,435,500	64 9	46 6	18 3	24,358,945
July	—	—	—	—	—
August	—	—	—	—	—
Sept.*	16,760,400	65 10	46 9	19 1	25,633,898
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	16,540,150	67 7	47 10	19 9	25,934,441
Jan., 1959	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	—	—	—	—	25,934,881

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
April, 1958	1,401,094	38,352	1,439,446
May	1,435,960	36,494	1,472,454
June	1,408,384	39,187	1,447,571
July	1,456,925	42,312	1,499,237
August	1,463,259	36,413	1,499,672
September	1,465,697	36,799	1,502,496
October	1,516,701	44,025	1,560,726
November	1,484,844	32,349	1,517,193
December	1,480,525	40,372	1,520,895
January, 1959	1,506,670	39,515	1,546,187
February	1,472,090	34,618	1,506,708
March	1,561,196	32,271	1,593,467

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
July 31, 1958	336,356	31,608	367,964
August 31	334,815	31,924	366,739
September 30	333,380	31,978	365,358
October 31	335,003	32,657	367,660
November 30	332,443	32,851	365,294
December 31	329,234	32,946	362,180
January 31, 1959	350,056	—	—
February 28	396,217	33,859	430,076
March 31	379,257	32,982	412,239

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To April 4		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	10,500	1,705	1,903
Electrolytic Zinc	15,867	718	4,837
Lake George	17,013	1,376	2,682
Mount Isa Mines**	62,628	3,930†	1,613
New Broken Hill	38,070	5,544	7,563
North Broken Hill	22,239	4,255	4,660
Zinc Corp.	35,540	6,660	6,848
Rhodesia Broken Hill*	—	—	—

* 8 Mths. ** Copper 1,165 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	March		April	
	Tons	Oz.	Tons	Oz.
Cam and Motor	32,273	—	—	—
Falcon Mines	20,000	3,761	20,000	3,778
Globe and Phœnix	6,200	3,033	6,000	3,483
Motapa Gold Mining	21,700	1,709	—	—
Mazoe	2,402	—	—	—
Coronation Syndicate	11,930	—	—	—
Phœnix Prince*	41,810	3,691	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	March		April	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	62,336	14,485	62,359	14,750
Ariston Gold Mines	40,000	12,546	41,640	12,584
Ashanti Goldfields	34,000	26,500	34,000	27,000
Bibiani	33,500	7,200	33,500	7,200
Bremang	—	3,791	—	—
Ghana Main Reef	11,668	4,346	12,547	4,328
Konongo	6,340	3,823	6,560	3,970
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1958		1959	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,305	46,553	46,489	18,077
February	43,591	21,313	43,366	19,806
March	43,830	8,179	—	—
April	46,587	22,573	—	—
May	46,015	19,937	—	—
June	46,453	20,105	—	—
July	44,244	19,170	—	—
August	47,484	20,549	—	—
September	48,295	21,141	—	—
October	46,311	6,342	—	—
November	47,904	16,435	—	—
December	48,888	30,724	—	—

WESTRALIAN GOLD PRODUCTION

	1957	1958	1959
	Oz.	Oz.	Oz.
January	106,722	66,562	63,924
February	64,949	65,965	65,035
March	67,121	65,420	65,408
April	66,435	60,855	—
May	64,886	64,196	—
June	65,142	67,929	—
July	74,420	81,106	—
August	75,727	68,610	—
September	64,422	68,744	—
October	64,524	70,128	—
November	65,700	67,562	—
December	66,562	120,106	—
Total	846,610	867,187	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Mar. 17		To Apr. 14	
	Tons	Oz.	Tons	Oz.
Central Norseman	21,217	12,662†	14,011	8,572
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	56,227	13,572†	36,918	8,871
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	47,089	8,999†	32,834	5,633
Hill 50*	—	—	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	167,972	38,542	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	1,735	614	—	—
Mount Ida*	8,263	3,638	—	—
New Coolgardie	—	—	—	—
North Kalgurli	26,799	5,940	13,175	3,155
Sons of Gwalia	10,284	2,276	9,812	2,123
Mount Morgan	—	4,811	—	—

* 3 Months. † 6 Weeks to Mar. 31.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
November, 1957	756,494	219,352	37,737	7,441,702
December	750,537	215,462	44,230	7,494,289
January, 1958	779,128	219,502	31,562	7,462,598
February	727,170	210,646	35,370	7,248,333
March	807,458	229,361	38,323	7,873,264
April	785,264	228,590	35,712	7,789,644
May	801,102	228,123	37,535	7,745,425
June	775,384	228,960	42,275	7,740,144
July	750,410	218,126	38,940	7,355,406
August	740,459	202,798	31,543	7,006,517
September	771,115	209,006	34,914	7,178,218
October	801,965	230,251	35,097	7,842,435
November	783,065	219,351	30,989	7,490,094
December	787,573	227,656	41,277	7,709,672
January, 1959	799,178	227,981	32,976	7,798,523
February	727,843	211,648	29,849	7,317,564

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Mar.		Apr.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	—	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	457	—	331
Emperor Mines (Fiji)*	—	—	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	—	—	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	37,436	—	35,400
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	3,543	2,051	—	—
St. John d'el Rey (Brazil)	—	—	—	—
Yukon Consol.	—	—	—	—

* 3 Months. † Oz. Silver : Copper, 61 : 85 tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Feb.	Mar.	Apr.
Ampat Tin	43½	50	51
Austral Amalgamated	—	—	—
Ayer Hitam	—	130*	—
Batu Selangor	—	—	—
Berjuntai	137½	112	92½
Chenderiang	—	21*	—
Gopeng Consolidated	—	109*	—
Hongkong Tin	—	41*	—
Idris Hydraulic	—	19*	—
Ipoh	—	46½*	—
Jelapang Tin	—	—	—
Kampong Lanjut	47	87½	62½
Kamunting	66	92	122
Kent (F.M.S.)	—	34*	—
Kepong	—	—	—
Killinghall	—	53¼*	—
Kinta Kellas	—	—	—
Kinta Tin Mines	—	59*	—
Klang River	—	—	—
Kramat	—	—	—
Kuala Kampar	106	110	115½
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	67	46½	55
Malayan	—	263*	—
Malaysiam	5½	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	372*	—
Pengkalen	—	58*	—
Petaling Tin	—	334*	—
Puket	—	—	—
Rahman Hydraulic	—	68*	—
Rambutan	—	20*	—
Rantau	38	23	25
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	112*	—
Selayang	—	35*	—
Siamese Tin Syndicate (Malaya)	25½	3	16
Southern Kinta	218	217	247
Southern Malayan	—	411*	—
Southern Tronoh	—	—	—
Sungei Besi	—	142*	—
Sungei Kinta	—	34½*	—
Sungei Way	—	182½*	—
Taiping Consolidated	26	46	39
Tambah	—	—	—
Tanjong	—	128½*	—
Tekka	—	19*	—
Tekka-Taiping	—	—	—
Temoh	—	13*	—
Tongkah Compound	—	—	—
Tongkah Harbour	35½	26½	29
Tronoh	—	495*	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	March		April	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	170	17	198	—
Anglo-Burma Tin *	45	—	—	—
Bangrin	34	—	30	—
Beralt	34	114†	40	117†
Bisichi	38½	22	39	32
Ex-Lands Nigeria	32	—	32	—
Geevor	55	—	55	—
Gold and Base Metal	24	3	—	—
Jantar Nigeria	8	15	9½	17
Jos Tin	9	—	—	—
Kaduna Prospectors	3	—	3	—
Kaduna Syndicate	13½	—	12½	—
Katu Tin	—	—	30	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	9	—	—	—
Naraguta Karama	4½	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	53	—	51	—
South Bukeru	—	—	—	—
South Crofty	73	—	78	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	—	—	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

February, 1959.

Gold	1,507,435 oz.
Silver	151,193 oz.
Diamonds	47,461 carats.*
Coal	2,946,857 tons.
Copper	(*a*) 77 tons in matte and copper-gold concentrates. (*b*) 4,367 tons of 99·36%.
Tin	220 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,007 tons.
Chrome Ore	51,660 tons.
Manganese Ore	75,952 tons.
Lead Concs.	— tons.

* Jan., 1959.

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		February	March
Iron Ore	tons	878,563	888,557
Manganese Ore	,,	27,408	23,574
Iron and Steel	,,	30,491	48,203
Iron Pyrites	,,	13,153	10,313
Copper Metal	,,	31,433	44,291
Tin Ore	,,	3,447	5,389
Tin Metal	,,	230	—
Lead	,,	8,479	22,252
Zinc Ore and Conc.	,,	972	6,156
Zinc	,,	15,674	15,437
Tungsten Ores	,,	60	320
Chrome Ore	,,	18,324	7,103
Bauxite	,,	26,710	43,541
Antimony Ore and Concs.	,,	1,036	1,765
Titanium Ore	,,	23,664	18,452
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	105	30
Sulphur	,,	21,772	35,872
Barytes	,,	3,088	2,566
Asbestos	,,	6,664	9,348
Magnesite	,,	1,430	2,122
Mica	,,	346	304
Graphite	,,	218	631
Mineral Phosphates	,,	100,066	88,262
Molybdenum Ore	,,	333	147
Nickel	cwt.	16,143	37,505
Aluminium	,,	353,890	451,975
Mercury	lb.	112,853	125,710
Bismuth	,,	90,418	130,399
Cadmium	,,	242,575	143,504
Cobalt and Cobalt Alloys	,,	193,901	316,896
Selenium	,,	5,726	8,051
Petroleum Motor Spirit	1,000 gals.	34,463	55,536
Crude	,,	824,777	818,234

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	,,	45	0	0
Boric Acid, Comml.	,,	75	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	11	0	0
Copper Sulphate	per ton	76	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		6	10
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Acetate, white	,,	124	0	0
,, Nitrate	,,	116	0	0
,, Oxide, Litharge	,,	104	5	0
,, Red	,,	102	5	0
,, White	,,	114	15	0
Lime Acetate, brown	,,	40	0	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2½
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride	,,	21	0	0
,, Iodide	per lb.		7	3
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	193	10	0
,, Sulphate, 50%	,,	21	1	0
Sodium Acetate	,,	75	10	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	15	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	15	0
,, Chlorate	,,	91	0	0
,, Cyanide 100% NaCN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	32	15	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	0	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	10	0
Sulphur, American, Rock (Truckload)	,,	14	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	7	0	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	109	0	0
,, Oxide	,,	95	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Apr. 8, 1959 £ s. d.	May 7, 1959 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	4 7 6	4 7 6
Blyvooruitzicht (2s. 6d.)	1 7 0	1 6 9
Brakpan (5s.)	5 0	5 0
Buffelsfontein (10s.)	2 6 9	2 7 6
City Deep	17 0	19 6
Consolidated Main Reef	1 0 3	1 0 6
Crown Mines (10s.)	1 4 0	1 4 6
Daggafontein (5s.)	1 8 3	1 9 3
Dominion Reefs (5s.)	15 0	14 3
Doornfontein (10s.)	1 11 6	1 12 0
Durban Roodepoort Deep (10s.)	1 13 6	1 13 3
East Champ d'Or (2s. 6d.)	2 0	2 3
East Daggafontein (10s.)	8 6	9 3
East Geduld (4s.)	1 3 3	1 5 6
East Rand Ext. (5s.)	1 11 3	1 12 6
East Rand Proprietary (10s.)	2 2 0	2 3 6
Freddies Consol.	2 6	2 6
Free State Dev. (5s.)	10 0	11 3
Free State Geduld (5s.)	8 13 9	8 18 0
Free State Saaiplaas (10s.)	18 6	19 0
Geduld	3 2 0	3 4 6
Government Gold Mining Areas (4s.)	3 9	3 9
Grootvlei (5s.)	17 3	17 9
Harmony (5s.)	2 1 9	2 1 0
Hartebeestfontein (10s.)	3 5 6	3 9 0
Libanon (10s.)	9 3	9 6
Loraine (10s.)	1 11 3	1 11 3
Luipaards Vlei (2s.)	9 6	10 6
Marievale (10s.)	1 5 6	1 6 0
Merriespruit (5s.)	7 6	6 9
Modderfontein B (3s.)	2 3	2 3
Modderfontein East	15 6	14 9
New Kleinfontein	4 6	5 0
New Pioneer (5s.)	2 1 3	2 1 0
New State Areas (15s. 6d.)	2 0	2 0
President Brand (5s.)	3 8 6	3 11 3
President Steyn (5s.)	1 12 9	1 12 3
Rand Leases (9s. 3d.)	7 0	7 3
Randfontein	1 4 6	1 3 6
Rietfontein (3s. 2d.)	6 3	4 9
Robinson Deep (5s. 6d.)	7 3	7 9
Rose Deep (6s. 6d.)	12 9	13 0
St. Helena (10s.)	2 17 9	2 16 6
Simmer and Jack (1s. 6d.)	2 6	2 3
South African Land (3s. 6d.)	1 0 9	1 2 6
Springs (5s.)	1 9	2 0
Stilfontein (5s.)	2 3 6	2 1 0
Sub Nigel (8s. 6d.)	13 0	13 0
Vaal Reefs (5s.)	1 19 0	2 1 3
Van Dyk (7s. 9d.)	5 0	5 0
Venterspost (10s.)	17 0	17 0
Virginia (5s.)	7 9	7 3
Vlakfontein (10s.)	17 6	19 6
Vogelstruisbult (10s.)	8 6	9 0
Welkom (5s.)	1 0 3	1 2 9
West Driefontein (10s.)	6 5 0	6 7 6
West Rand Consolidated (10s.)	1 4 6	1 4 0
West Witwatersrand Areas (2s. 6d.)	2 14 6	2 18 3
Western Holdings (5s.)	7 1 3	7 8 6
Western Reefs (5s.)	1 8 6	1 10 0
Winkelhaak (10s.)	1 1 6	1 2 6
Witwatersrand Nigel (2s. 6d.)	1 3	1 3
Zandpan (10s.)	19 3	19 9
RHODESIA:		
Cam and Motor (2s. 6d.)	7 9	9 0
Chicago-Gaika (10s.)	15 0	16 0
Coronation (2s. 6d.)	4 0	4 0
Falcon (5s.)	7 3	7 9
Globe and Phœnix (5s.)	1 9 6	1 11 9
Motapa (5s.)	9	9
GOLD COAST:		
Amalgamated Banket (3s.)	1 2	1 3
Ariston Gold (2s. 6d.)	4 9	4 3
Ashanti Goldfields (4s.)	1 0 0	16 6
Bibiani (4s.)	2 3	2 6
Bremang Gold Dredging (5s.)	1 9	1 9
Ghana Main Reef (5s.)	2 3	2 3
Konongo (2s.)	1 11	1 9
Kwahu (2s.)	3 6	4 0
Western Selection (5s.)	5 6	5 3
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	2 0	2 0
Gold Mines of Kalgoorlie (10s.)	8 6	8 9
Great Boulder Propriet'y (2s.), W.A.	12 6	12 9
Lake View and Star (4s.), W.A.	1 6 0	1 7 0
London-Australian (2s.)	9	11
Mount Morgan (10s.), Q.	13 3	13 6
New Guinea Gold (4s. 3d.)	2 0	2 0
North Kalgurli (1912) (2s.), W.A.	10 6	11 0
Sons of Gwalia (10s.), W.A.	2 6	3 6
Western Mining (5s.), W.A.	10 3	11 0

	Apr. 8, 1959 £ s. d.	May 7, 1959 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 15 0	1 13 9
Kentan Gold Areas	2 0 9	2 0 6
St. John d'el Rey, Brazil	4 5 3	4 7 6
Yukon Consolidated ($1)	5 0	5 0
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	1 9 3	1 7 0
Esperanza (2s. 6d.), Cyprus	1 10½	1 7½
Indian (2s.)	5 0	5 0
MTD (Mangula) (5s.)	9 9	10 0
Messina (5s.), Transvaal	5 17 6	5 8 3
Mount Lyell, Tasmania	1 4 3	1 4 3
Nchanga Consolidated, N. Rhodesia	10 16 3	11 2 6
Rhokana Corporation, N. Rhodesia	26 5 0	26 15 0
Roan Antelope (5s.), N. Rhodesia	8 9	8 9
Tanganyika Concessions (10s.)	2 7 6	2 9 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	—	10 9
Burma Mines (3s. 6d.)	2 0	2 0
Consol. Zinc Corp. Ord.	3 1 3	3 1 9
Lake George (5s.), N.S.W.	3 6	4 0
Mount Isa, Queensland (5s. Aust.)	1 11 3	1 16 6
New Broken Hill (5s.), N.S.W.	1 12 3	1 15 3
North Broken Hill (5s.), N.S.W.	3 18 6	4 1 3
Rhodesia Broken Hill (5s.)	8 6	8 6
San Francisco (10s.), Mexico	19 6	19 3
TIN:		
Amalgamated Tin (5s.), Nigeria	6 9	7 3
Ampat (4s.), Malaya	8 3	9 6
Ayer Hitam (5s.), Malaya	1 13 0	1 19 0
Beralt (5s.), Portugal	1 9 0	1 10 6
Bisichi (2s. 6d.), Nigeria	3 3	4 0
Ex-Lands (2s.), Nigeria	2 0	2 3
Geevor (5s.), Cornwall	1 0 0	1 3 6
Gold Base Metals (2s. 6d.), Nigeria	1 0	1 0
Hongkong (5s.), Malaya	5 3	4 3
Jantar Nigeria (3s.)	3 3	3 9
Kaduna Syndicate (2s.), Nigeria	2 0	2 3
Kamunting (5s.), Malaya	10 9	12 6
Malayan Tin Dredging (5s.)	15 6	17 0
Mawchi Mines (4s.), Burma	2 6	2 6
Naraguta Extended (5s.), Nigeria	9	9
Pahang (5s.), Malaya	4 9	5 9
Siamese Synd. (5s.)	8 9	9 9
South Crofty (5s.), Cornwall	4 0	4 0
Southern Kinta (5s.), Malaya	1 1 9	1 2 9
Southern Malayan (5s.)	13 3	14 9
Southern Tronoh (5s.), Malaya	11 6	13 3
Sungei Besi (4s.), Malaya	17 9	1 0 3
Sungei Kinta, Malaya	14 0	16 0
Tekka (12s. 6d.), Malaya	4 3	4 0
Tronoh (5s.), Malaya	13 0	14 3
United Tin Areas (2s. 6d.), Nigeria	7½	1 0
DIAMONDS:		
Anglo American Investment	11 15 0	12 10 0
Consol African Selection Trust (5s.)	17 9	19 3
Consolidated of S.W.A. Pref. (10s.)	10 6	10 6
De Beers Deferred (5s.)	6 8 9	6 18 9
FINANCE, Etc.		
African & European (10s.)	4 5 0	4 2 6
Anglo American Corporation (10s.)	8 15 0	8 18 9
Anglo-French Exploration	1 7 9	1 9 3
Anglo Transvaal 'A' (5s.)	2 1 0	2 1 6
British South Africa (15s.)	4 6 0	4 11 0
British Tin Investment (10s.)	19 9	1 1 3
Broken Hill Proprietary	2 5 0	2 1 9
Camp Bird (10s.)	13 3	12 6
Central Mining	3 16 3	4 0 6
Central Provinces Manganese (10s.)	1 12 6	1 10 0
Consolidated Gold Fields	3 6 0	3 9 0
Consolidated Mines Selection (10s.)	1 19 6	2 0 0
East Rand Consolidated (5s.)	2 0	2 0
Free State Development (5s.)	10 0	11 3
General Exploration O.F.S. (2s. 6d.)	5 3	6 3
General Mining and Finance	6 12 3	6 15 9
H.E. Proprietary (5s.)	16 0	15 6
Johannesburg Consolidated	2 18 6	3 6 9
London & Rhod. M. & L. (5s.)	7 6	7 9
London Tin Corporation (4s.)	9 0	10 0
Lydenburg Est. (5s.)	17 0	18 3
Marsman Investments (10s.)	1 9	1 9
National Mining	1 9	1 9
Rand Mines (5s.)	4 7 9	4 10 0
Rand Selection (5s.)	2 10 0	2 10 3
Rhodesian Anglo American (10s.)	3 15 0	3 18 0
Rhodesian Corporation (5s.)	3 3	3 3
Rhodesian Selection Trust (5s.)	15 6	16 6
Rio Tinto (10s.)	2 11 3	2 12 6
Selection Trust (10s.)	5 2 0	5 8 9
South West Africa Co. (3s. 4d.)	13 9	12 6
Union Corporation (2s. 6d.)	2 13 9	2 19 3
Vereeniging	5 18 9	6 1 3
West Rand Inv. Trust (10s.)	2 15 6	2 17 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Tungsten Minerals in South China and Hong Kong

A paper by S. G. Davis in the *Proceedings* of the Eighth Pacific Science Congress, Vol. II—A, reviews "The Distribution and Occurrence of Tungsten Minerals in South China and Hong Kong." In it the author says that the area under consideration in South China is Kiangsi, Hunan, Kwangtung, and Kwangsi; other deposits in Manchuria, Hopei, Sinkiang, Yunnan, and Chekiang are not considered.

In normal times, the author continues, China is the world's largest producer of tungsten ores. Mining is generally primitive and slow hand methods and poor dressing operations have resulted in low recovery. Estimates of ore reserves have been hazarded from time to time, but the whimsical occurrence of the mineral makes it impossible for these to be reliable.[1] The area is something more than 100,000 square miles, characteristically mountainous, with a general trend of north-east to south-west; this is also the trend of structure and rock formations. Places in the area are generally under 2,000 ft. but some ridges and crests exceed 3,000 ft. Erosion processes have been going on long enough to produce well-defined drainage patterns and a mature topography.

The area forms part of the great batholith of igneous rocks which stretches in a north-easterly to a south-easterly direction from Hangchow Bay in the north to Cambodia and Thailand in the south. In general the igneous rocks are acidic in character. The oldest would appear to be associated with the mountain building of the Jurassic (Yen Shan No. 1), Laramide (Yen Shan No. 2), and Alpine revolutions. Metallization has been intimately associated with these intrusive rocks and the related metamorphism. In Kiangsi and Hunan the rocks sequence is continuous from very recent to Silurian. Sedimentary series occur belonging to the Cretaceous, Trias, Permian, and Carbonaceous. Intrusive rocks, mainly acid and characteristically granitic, have invaded the local country rocks to form pegmatites, mica, and chlorite schists, phyllites, quartzites, and innumerable quartz veins, dykes, and sills. Detailed geological investigations on the occurrence of the tungsten deposits in their relation to the main geological sequences are for the most part lacking. The exception to this is the very detailed investigations of southern Kiangsi by Hsu and Ting.[1]

The tungsten ores which have to date been economically exploited in the wolframite group are: Ferberite—$FeWO_4$, wolframite—(Fe, Mn) WO_4, hubnerite—$(MnWO_4)$. In the Scheelite group: Scheelite—$CaWO_4$, cuproscheelite—(Ca, Cu)WO_4. The presence of raspite ($PbWO_4$) has not been so far recorded nor have others of the scheelite group such as powellite, stolzite, and wulfenite. The mineralization of these tungstates occurs in many ways. Most commonly they are associated with granite masses which are offshoots of the great underlying batholith. Pegmatite veins, which have been formed under pneumatolytic conditions, usually carry wolframite which is often associated with cassiterite. Sometimes sulphide minerals are also present in the veins. The principal tungsten-producing district in Kiangsi is at Si Hwa Shan near Nanan. Other centres are Chung Ye, Ta Yu, Nankang, and Shan Yu. The deposits mined here are mainly alluvial having been derived from the pegmatites in the Nan Ling range. In Hunan the most important mining centres are in the districts of Jucheng, Tzushing, Yichang, Yao Kang Hsien, and Cheng-hsien. These are all, with the exception of Yao Kang Hsien, underground. In Kwangtung there are numerous wolframite deposits in the district north of Hong Kong. A district with a steady production is along the coast of southern Kwantung, near Yeung Kong. Two islands just south of Yeung Kong lead in output. The tungsten ore occurs on the contact of granite bosses.

The discovery of tungsten in South China dates back only to 1915. To-day about 95% of the entire Chinese output comes from Kiangsi, Hunan, and Kwantung. Of these three it would appear that Kiangsi is the most important producer, contributing just over half of the entire China output. The Nan Ling, which consist of well-folded mountains intruded by granite, are the centre of the richest bearing tungsten deposits. In southern Kiangsi quartz veins bearing tungsten are commonly perpendicular to the bedding planes as small dykes. This is typical in the districts of Shang-ping, Piao Tang, Peshih, Ta Yu, Nankang, Tsungi, Shangyou, and Tachishan. In southern Kwangsi, in the district of Pat Po, wolframite is found in

[1] The China Handbook, 1937–46, gives the total for China as 2,035,300 tons. The China Handbook, 1952–53, gives 5,342,800 tons. Report of "Manganese and Tungsten Ore Resources in China," April, 1953, ECAFE Conference, Tokyo, gives 2,060,300 tons.

[1] Hsu, K. C., and Ting, I. "Geology and Tungsten Deposits of Southern Kiangsi." National Geological Survey of China.

economic quantities associated with cassiterite and gold deposits. It occurs in pegmatites and greisen.

In Hong Kong and the New Territories tungsten ores are being mined at present in 12 different places. The ore occurs typically in pneumatolytic veins surrounding the granite masses and is most abundant in the junction beds between the Tai Mo Shan porphyry and the Hong Kong granite. Generally the veins are fissure fillings ranging from quartz stringers to pegmatites.

The tectonics of the southern Kiangsi tungsten districts are interesting. There is a marked easterly potential in all the quartz veins and stringers. Sometimes there is a variation to the north and sometimes to the south, but this is usually not more than a 30° deviation. The characteristic country rock in this area is of granite and sandstone. Along the contact of the granite and sandstone greisen commonly occurs as also do gneisses and schists. Here pegmatites consist predominantly of massive orthoclase and quartz. Additional to these two minerals, muscovite, biotite, zircon, tourmaline, topaz, and feldspar occur in small quantities. Associated mineral ores are molybdenum, cassiterite, and pyrite. The predominant tungsten mineral throughout this region of southern Kiangsi is wolframite. Its concentrates are remarkably constant containing 62% to 67% WO_3.

In Hunan the tungsten deposits are also predominantly wolframite. Associated with the wolframite are large muscovite plates sometimes as large as 15 cm. square. The occurrence of this muscovite, which is golden in colour, is to the prospector in the field an indication of the presence of wolframite. Also associated in fairly large quantities is cassiterite. This is typical in the Yun Tai Shan and Yao Kang Shien mines.

In Hong Kong there are two characteristic occurrences of tungsten-bearing ores. One is in pegmatite that has been formed by the intrusion of the Hong Kong granite into the Tai Mo Shan porphyry. The other is where the granite has established a contact zone with the Lok Ma Chau schists. This has resulted in the ore deposit being concentrated in a roof pendant. It is the coarseness of the crystalline structure which characterizes the ore deposit. The following minerals are usually present in various degrees of abundance : orthoclase feldspar, quartz, wolframite, molybdenite, magnetite, muscovite, and manganese. The wolframite everywhere occurs in association with quartz veins. The geological evidence of the mines at Castle Peak, Lin Fa Shan, Sha Lo Wan, and Devil's Peak shows that the upper part of the batholith or summit of the cupola concentrated in the roof pendant magmas which were rich in mineralizers. Thus there is a relative richness of the tungsten ores and tin. Another feature, especially of quartz, is that when the width is greater than 2 ft. the chances of finding ore minerals is remote. It has been consistently noted that the best ore yielding quartz veins are from 2 in. to 12 in. thick. At Wong Nai Tung a detailed survey of the quartz veins and stringers showed the presence of manganese together with iron pyrites in larger amounts than elsewhere.

In the Lyemun Black Hill district of the New Territories the wolframite bearing rocks occur where the Hong Kong granite has intruded into the Repulse Bay volcanics. The contact rock here, at the base of the roof pendant, is pegmatite. It is highly mineralized and is characterized by muscovite which occurs in masses of purple-coloured disintegrated rock. This distinctive purple colour is derived from manganese dioxide. The Haiwan area is also distinctive from other Hong Kong areas, inasmuch as the normal resistant pegmatite has given way to a pegmatite which is already well advanced in disintegration. All along this main contact the pegmatite displays the characteristics of large massive crystals of orthoclase interwoven with quartz. This feldspar is mined commercially and sold to the ceramic and enamel industries for use in glaze.

At the north-eastern end of Lantau Island wolframite occurs in quartz veins and stringers. The Tai Mo Shan porphyry has been intruded by Hong Kong granite. These quartz veins and stringers lead off from two main dykes. These two main dykes are about 18 in. in width. The narrower quartz veins and stringers intersect and interlace one another. Wolframite and molybdenite occur in these quartz veins. A constant indicator of the presence of these minerals is the presence of golden muscovite. (Indicative to-day of the low price of molybdenite is the presence of dumps of tailings with many tons of molybdenite in them.) In general this area has the granite ranging from coarse to fine grain, fan-shaped, and radial fissuring in usual systems, with structural evidence of faulting and fracturing. At Ho Chung and Shing Mun the wolfram-bearing rocks are distinguished by the numerous cavity fillings. At Wong Nai Tung a vug in the granite was lined with crystalline calcite carrying small pyrite crystals, evidence of the penetration of solutions of magmatic origin. At Ma on Shan many small vugs yield good crystals of fluorspar, quartz, and scheelite.

Disintegration and weathering of the coarse-grained granites and greisen on the north-eastern end of Lantau have freed the wolframite from the gangue minerals. This has provided a residual deposit which can easily be worked by sluicing and panning. The exploitation of the ore by sluicing is unfortunately producing a vegetationless badland.

At Lin Fa Shan, in the New Territories, wolframite and scheelite have been found in close association. Fluoroscopic examination shows the scheelite as approximately one-third of the concentrate to two-thirds wolframite. This close association of the two tungstates is unfortunate commercially. It is necessary to separate them before they can be treated chemically for industrial purposes. The Hong Kong scheelite fluoresces usually to a white colour, although occasionally some specimens colour up as blue-white. Sometimes it forms in solid veins but most usually as disseminated crystals averaging 5 mm. to 10 mm. in size.

In South China and Hong Kong the tungsten ores, although widely distributed, never occur in massive form. They occur in narrow veins usually. The tungsten content of the ore as it is mined is usually not greater than 2% ; the final ore concentrate usually contains about 65% WO_3. Where tin occurs with the tungsten in the concentrate it is separated by magnetic methods ; scheelite, being non-magnetic, can also be separated from the wolframite. However, it has been discovered with the ore from Lin Fa Shan that excessive crushing leads to high losses in tabling and it is desirable that the ore should, as far as possible, be separated when coarsely crushed.

In South China there has been no diminishing of

tungsten ore production when it has been needed. The loose residual surface deposits in the weathered granite are, together with the tungsten-bearing surface outcrops, the most generally worked. The exploitation of deposits well below the ground surface has barely begun because this involves up-to-date mining methods, ventilation, and capital. A typical analysis of Hong Kong wolfram shows 65·27% WO_3, 10·45% Fe, 13·38% Mn, with 2·14% Sn.

Fracture in Rock Faces

"The Experimental Determination of the Extent and Degree of Fracture of Rock Faces by Means of an Ultrasonic Pulse Reflection Method" is the title of a paper by A. Lutsch appearing in the *Journal* of the South African Institute of Mining and Metallurgy for March. In his introduction to the paper the author says that the development of methods for measuring the extent and degree of fracture of the rock at a stope face or side wall of a drive is an important subject of research into the rockburst problem. Such methods could be useful, he says, not only in determining the condition of the ground around excavations at depth, but would also provide a means of establishing quantitatively the effectiveness of a de-stressing blast insofar as it has been successful in increasing the depth of the zone of fractured rock ahead of a face.

Three methods of approach were investigated in the study described—namely, the "time-delay-along-a-surface" method, the "time-delay-in-depth" method, and the ultrasonic pulse reflection method. In the course of the investigations the time-delay-along-a-surface method was abandoned because the conditions prevailing at fractured rock faces did not lend themselves to the application of this method. The principle of the time-delay-in-depth method is based upon the assumption that the travel time of sonic waves transmitted through rock is affected by the degree to which the rock is fractured. The ultrasonic pulse reflection method on the other hand utilizes the phenomenon that ultrasonic waves transmitted through rock are reflected from cracks and other discontinuities, so that the number of reflected pulses indicates the degree of fracturing of the volume of rock inspected.

The nature of sonic and ultrasonic wave propagation in rock was investigated with special reference to the influence of the pressure to which the rock is subjected. Any discontinuity in a solid body causes a reflection of ultrasonic pulses transmitted through the body. If, therefore, ultrasonic pulses are transmitted through a rock specimen or through rock *in situ* and reflected pulses are observed on the screen of a suitable recording apparatus, it can be concluded that the rock is fractured; if no reflected pulses are observed the rock may be considered as being unfractured. Furthermore, the number of reflected pulses observed on the screen is a measure of the degree to which the body or the inspected portion of the body is fractured. To conduct a test a probe is pushed into a hole and by rotating it through 360° records may be obtained for a circular area 6 ft. to 10 ft. in diameter around the hole. The probe is first pushed to a depth where no cracks are expected and then gradually withdrawn to a point where reflected pulses are first observed. This point determines the boundary of the fractured zone. The number of reflected pulses observed per unit circular area is a measure of the degree of fracture.

In an attempt to determine the extent and degree of fracture of a rock face, three methods were applied:—

(i) The ultrasonic pulse reflection method.

(ii) The (sonic) time-delay-along-a-surface method.

(iii) The (sonic) time-delay-in-depth method.

The time-delay-along-a-surface method was abandoned during the course of the investigations.

The time-delay-in-depth method is based on the assumption that the travel time of sound depends on the degree of fracture of the medium through which sound waves are transmitted. Hence, the time delay between the transmitting of a sound wave at the beginning and receiving its signal at the end of a given distance interval would be a measure of the degree to which the rock in this distance interval is fractured.

The ultrasonic pulse reflection is based on the phenomenon that sound waves transmitted through a medium are reflected at discontinuities—*e.g.*, cracks—so that the pattern of the reflection pulse traces obtained on a recorder screen is a measure of the degree to which the medium is fractured. Although the velocity of sound can be measured using this method the knowledge of the velocity of sound is not essential for the method.

The advantages and disadvantages of both methods at present in use are said to be:—

(i) The velocity of sound in the transition zone and in the solid ground shows a considerable scatter (up to 25% from the mean). Any method based on measurements of the velocity of sound—*e.g.*, the time-delay-in-depth method—will hence not be able to reveal fine differences in degree of fracture, as they occur between the transition zone on the one hand and the fractured zone or solid ground on the other hand, since the influence of fine cracks on the travel time of sound is obscured by the scatter of the results of measurements. Nevertheless, the time-delay-in-depth method is able to detect greater differences in travel time of sound, *e.g.*, between the fractured zone and the solid zone. It must hence be concluded, says the author, that the ultrasonic pulse reflection method is superior to the time delay method as far as sensitivity is concerned since it is not affected by changes in velocity of sound and is able to detect the boundaries between fractured zone, transition zone, and solid ground more clearly.

(ii) The records obtained from the ultrasonic pulse reflection method can more easily and more readily be interpreted than those of the time-delay-in-depth method. In the case of the ultrasonic pulse reflection method the operator needs only to observe the record pattern on a screen and to compare it with typical patterns to decide whether the zone inspected belongs to the fractured zone, the transition zone, or the solid ground. In the case of the time delay method the results must first be plotted

in a graph, curves must be drawn, and then the curves obtained must be interpreted.

(iii) The results of the ultrasonic pulse reflection method are not obscured by noise due to fans, jackhammers, and conveyances.

(iv) The application of the ultrasonic pulse reflection method requires a diamond-drilled hole, while for the time-delay-in-depth method a hole drilled by means of a tungsten carbide tool will be sufficient. This is a feature in favour of the time delay method which might partly compensate for the fact that the volume of rock inspected per hole drilled is considerably larger in the case of the ultrasonic pulse reflection method. (With the time-delay-in-depth method only the rock at the skin of the hole is inspected, which moreover has the disadvantage that the cracks in the skin which are due to the drilling operation and not a feature of the area inspected may obscure the results.)

As far as the ultrasonic pulse reflection method is concerned, the results obtained were so encouraging that a new small instrument, which will be battery operated, is being built in the South African National Physical Research Laboratory. Its weight and size will be kept to a minimum and its housing will be moisture-proof.

Iron by Direct Reduction

In the Canadian Mines Branch Circular IC 109, R. R. Rogers, head of the Chemical Metallurgy Section of the Mineral Dressing and Process Metallurgy Division, discusses the present status of the "Direct Reduction of Iron." He says that at the present time ferrous metallurgists in every country are carefully scrutinizing the methods of producing iron now in use and comparing them with the numerous new methods which are being developed. The blast-furnace method is by far the most important at the present time because it enables large quantities of the metal to be produced at a comparatively low price. However, it is becoming increasingly evident that this method has certain important disadvantages; the cost of a modern blast furnace and its auxiliaries is tremendous and there is comparatively little flexibility in its operation. In many large and important areas good coking coal is not available at a reasonable price and in other areas the market is not great enough to utilize the large amount of iron produced in a single blast furnace. Some authorities believe that, in spite of these handicaps, the blast furnace will overcome all serious competition for many years to come because of the important advances which are being made in production methods. They point out that a blast furnace built to-day can produce about 67% more iron than a similar-sized furnace could have produced in 1940. Other authorities believe that few more blast furnaces will be built and that additional requirements of iron will be met by the use of other methods of reducing the ore. Perhaps the most realistic prediction, the author says, is that the number of blast furnaces will be increased at a sufficiently high rate to take care of the needs of those large industrial areas which are located within a reasonable distance of adequate coal supplies. The exact nature of the reduction process used in each of the remaining areas will be determined by the conditions existing in that area, such as its location, the type of ore most readily available, and the presence of oil, gas, coal, or electric power in the vicinity.

Among the processes under serious consideration at present are those that take place by direct reduction. Another type of process of particular interest in Canada, where power is unusually cheap, is that in which the iron ore is fed directly into an electric smelting furnace and the product is pig iron.

Direct reduction is said to take place when iron ore in the solid state is converted to metallic iron in the same state. The great majority of the direct reduction processes belong to one of the following types: Fluidized bed, rotary kiln, and vertical shaft or retort. Some of them are continuously operated, others are batch processes; some have been operated for a considerable length of time in commercial-size equipment and others have only reached the pilot-plant stage.

H-Iron Process (fluidized bed, batch).—This is an American process for the reduction of dry, finely-divided, high-grade iron ore by hydrogen of at least 95% purity. The comparatively low operating temperature of about 482° C. (900° F.) ensures that the particles of charge and product do not adhere together and that the reduction takes place in the steps $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow Fe$, avoiding the slow reaction $FeO \rightarrow Fe$. It also makes possible the use of a comparatively inexpensive material of construction. The fairly high pressure of 400 p.s.i. is advantageous because of the higher rate of reaction, the lower capital cost due to the smaller equipment required, and other reasons. Haematite and magnetite ores can be used equally well, but an ore of high iron content should be used since none of the gangue is removed during the reduction. Comparatively few natural ores are sufficiently pure for use without beneficiation. The H-Iron process is at present in the pilot-plant stage.

Madaras Process (vertical retort, batch).—This is also an American process in which the iron ore, in small lumps or pellets, is reduced by a 3 : 1 mixture of hydrogen and carbon monoxide produced from natural gas. The ore is preheated for about 5 hours and then the gas is introduced at a temperature of about 982° C. (1,800° F.). The reduction requires two or more hours. The gas enters the retort at 30 p.s.i. and is pulsated 21 times per minute by opening and closing a valve in the discharge pipe. The process is still in the pilot-plant stage.

Wiberg-Soderfors Process (vertical shaft, continuous).—This process was first operated on an industrial scale in Sweden in 1932, but was not run continuously until 1941. Haematites such as the Canadian Steep Rock ore and certain magnetites may be used. At Soderfors a magnetite sinter containing about 62% Fe is charged. Rich concentrates in the form of pellets also have given satisfactory results. The reducing gas consists of carbon monoxide and hydrogen in the proportions of about 75 : 25, although this ratio is not particularly critical. The reduction with carbon monoxide is exothermal and that with hydrogen is endothermal and the proportions of these gases are

chosen so that the heat produced in the first reaction just compensates for that absorbed in the second reaction *plus* the heat losses. According to the most recent information available the product contains 80% total Fe and 70% metallic Fe, corresponding to a reduction of 87%. Each unit has a daily output of 27 tons.

Stelling Process (fluidized bed, continuous).—This has been developed to the pilot-plant stage in Sweden. The reduction takes place by means of carbon monoxide only. Haematite concentrates are pre-reduced to ferrous oxide (FeO) at about 750° C. (1,382° F.). The latter is introduced into a fluidized bed having cementite (FeC_3) as the main constituent and a temperature of about 600° C. (1,112° F.). Reduction here takes place by means of the carbon monoxide which passes through the bed. When the ratio between the cementite and ferrous oxide has reached the desired value the mixture of materials is removed. On heating at 750° C. (1,382° F.) or higher the cementite and ferrous oxide react to form metallic iron. The spent reducing gas is passed through a carburettor to increase its carbon monoxide content and then is re-used. If the original ore is magnetite a preliminary oxidation to haematite is highly desirable.

R-N Process (rotary kiln, continuous).—This has been operated in the U.S.A. on a pilot-plant scale only. The ore, solid carbonaceous material (coke breeze, anthracite fines, etc.) and limestone (or dolomitic limestone) are fed into the rotary kiln. The amount of carbonaceous material fed is several times the actual requirement, resulting in the re-cycling of 75% of this material. The kiln may be fired with gas or oil. As the ore travels through the kiln, counter-current to the heat flow, it is dried, preheated, and reduced. The reduction always takes place at a temperature below the melting point of substantially all of the constituents of the charge, including the iron. The temperature range in the kiln varies according to the nature of the ore, a typical range being 982° to 1,093° C. (1,800° to 2,000° F.).

The materials discharged from the kiln are cooled and separated by screening. Then they are separated further by gravity or magnetic means. The excess carbon is cleaned, dewatered, and returned to the kiln for re-use. The magnetic portion is freed from gangue by grinding and further magnetic and gravity procedures. Two different products are obtained: (1) Total iron %, > 95, metallic iron %, > 90, and silica %, < 8; (2) 85% total iron, > 70% metallic iron, and silica, < 8%. These are briquetted to provide feed for the open-hearth or electric furnace in the first case and for the blast furnace in the second case. Sometimes it is desirable to combine these two products prior to briquetting. It is claimed that both magnetic and non-magnetic ores, having a wide range of iron content, may be treated by this process.

Kalling Process (rotary kiln, continuous).—This has been operated on a pilot-plant scale in Sweden with a view to producing cheap iron. Purity of product was a secondary consideration. It was believed that former direct reduction experiments in rotary kilns had met with only limited success primarily because of difficulties in preventing the ore from balling in the furnace or from forming rings on the walls in the hottest zone. The latter seemed to be the most difficult to avoid.

There is a very narrow margin between the temperature required for a sufficiently rapid and complete reduction of the ore and that at which sticking of the ore occurs. In the Kalling process the charge usually has consisted of finely-crushed sinter and coke breeze, the latter being considerably in excess of that required for reduction of the ore. The air required for the combustion of the coke and of the carbon monoxide formed during the reduction is introduced through a central pipe inserted in the furnace and passes through openings in the pipe in the reduction zone. Because of this arrangement the temperature of the charge is kept fairly close to that of the furnace wall and the risk of sticking is greatly decreased. The reduction temperature usually has been in the range 1,050° to 1,100° C. (1,922° to 2,012° F.). Magnetite ores are in general preferred to haematite ores as they do not disintegrate so much during reduction. Good results are more difficult to obtain if the melting point of the gangue is too low. Reduction of 85% to 95% has been obtained, the product containing an average of about 1% of carbon. A large proportion of this carbon may be removed by fine grinding and magnetic separation. The phosphorus content of the product is generally somewhat higher than that of the ore and the sulphur absorption from the coke is considerable. Important advantages of the process are the low consumption of fuel and the fact that cheap grades of reductant can be used. The method is not suitable for the reduction of finely-divided ores.

Strategic-Udy Process (rotary kiln, continuous).—This has been operated on a pilot-plant scale in Canada.[1] It is claimed that fines, off-grade ores, and ores contaminated with titania or similar deleterious materials, as well as standard iron ores, may be treated. The ore with essential fluxes and carbonaceous reductant is fed into a direct-fired rotary kiln. Emphasis is placed on the speed of throughput of a free-flowing system of solid particles with a discharge temperature of about 1,100° to 1,300° C. (2,012° to 2,372° F.), rather than on complete reduction. The maximum temperature of the kiln operation is determined by the point at which a free-flowing product is produced without ring formation in the kiln. The product from the kiln is transported to an electric smelting furnace in which reduction of the ore is completed.

Krupp-Renn Process (rotary kiln, continuous).—This has been in operation on a commercial scale in Germany and elsewhere since 1939. It has been particularly successful in treating low-grade ores, even though they may contain a considerable amount of silica. The final slag usually contains 55% to 65% SiO_2. Ores containing higher than 50% Fe are diluted with slag from the process. Even fairly low-grade fuels can be used successfully for the heating and reduction.

As the mixture of ore and solid carbonaceous material proceeds down the kiln, its temperature gradually rises until reduction commences at about 600° C. (1,112° F.). When a temperature of about 1,100° C. (2,012° F.) has been reached, additional heat is introduced to achieve a final temperature as high as 1,250° C. (2,282° F.). The charge remains in this zone for several hours while the iron particles are welded together to form "lupen," which remain distributed in the pasty slag and are discharged with it. The "lupen" lumps are separated from the slag magnetically.

[1] See THE MINING MAGAZINE, Feb., 1959.

Block Caving in an Arizona Copper Mine

Block-caving mining methods and costs at the Bagdad mine of the Bagdad Copper Corporation are described by W. R. Hardwick in Information Circular 7890 of the United States Bureau of Mines. The mine is on Copper Creek, in the Eureka mining district of Arizona. In 1919 the Arizona-Bagdad Copper Co. acquired the claims, did some churn-drill sampling, then attempted to leach the ore in place. The leaching was not successful and in 1927 the present Bagdad Copper Corporation succeeded. A 50-ton pilot plant was operated in 1929 and the results were favourable. Plans then were made to mine 3,000 tons of sulphide ore per day by the block-caving method and to mill this ore by flotation. In 1940 and 1941, at a rate of 250 tons per day, the company made a small operating profit for the first time. The ore was being successfully mined by the caving method and mill recovery was satisfactory; however, the results indicated that greater profits would result if plant capacity were increased.

Under the stimulus of premium prices for copper and with the help of a loan of $2,500,000 from the Reconstruction Finance Corporation (R.F.C.), a 2,500-ton-per-day flotation mill was built and the mine was expanded for larger production by the block-caving method. The ore-body was thin and the rock was hard for block caving. Successful caving depended on small blocks; boundary drives and corner rises were necessary. During World War II labour was scarce and stope development lagged. Existing blocks were drawn rapidly, with the result that dilution was high and copper recovery was low. To increase production ore was mined by converting some caved stopes to glory holes where the capping was thin. Finally the mining method was changed and the open-pit method with truck haulage was adopted. The underground operation was discontinued in 1948 after about 4,000,000 tons of ore had been mined.

The copper minerals in the Bagdad mine occur in minor fractures and as disseminated grains in a quartz monzonite, which form a typical "porphyry" copper deposit. Molybdenite is common and a molybdenum sulphide by-product is separated from the copper concentrate and sold. Quartz monzonite crops out as an irregular stock that contains the ore-body. Along Copper Creek sulphide ore occurs almost to the surface. Generally it is capped by 150 ft. to 200 ft. of leached rock or carbonate ore, 200 ft. of Gila conglomerate, and 50 ft. of basalt. The west ore-body, which the company proposed to mine by caving, was roughly tabular and approximately 1,400 ft. by 800 ft. in area; mineable thickness averaged 125 ft., the deposit dipping 10° to 15° to the north-east. The quartz-monzonite stock is roughly 2 miles long, east and west, and 1 mile wide, north and south. It joins a schist complex on the north and is enclosed by a granitic complex on the other sides. A low-grade ore-body covers a much larger area than the high-grade west ore-body, which was mined by caving before 1948.

Ore first was discovered by underground work at Bagdad when adits were driven into the banks of Copper Creek. In the more important parts of the ore-body churn-drill sample holes were spaced at 100-ft. intervals and in the remainder of the ore-body at 200-ft. intervals. Samples were split from the sludge for each 5-ft. vertical interval in the drill holes. Cuttings were examined for type of rock and assayed for copper content. The results were recorded in drill-hole logs and plotted on sections. Volume for various grades of ore was calculated and converted to tons by using a factor of 1 ton for each 12½ cu. ft. of ore in place. In 1936 various estimates had placed ore reserves at 1,000,000 tons to 6,000,000 tons of *plus* 1·5% copper sulphide ore and 20,000,000 tons to 40,000,000 tons of 1·25% copper ore. The last information published places sulphide reserves at 30,000,000 tons, with an average grade of 0·754% copper and oxide-carbonate reserves at 300,000,000 tons, with an average grade of 0·435% copper.

By 1930 the mine had been developed through two shafts. No. 1 shaft, 100 ft. deep, was equipped with a 50-ft. timber headframe and a single-drum hoist powered by a 40-h.p. motor. No. 2 shaft (depth unknown) was equipped with a 45-ft. steel headframe. Cars were caged and hoisted with a double-drum hoist operated by a 100-h.p. electric motor. No. 2 shaft was used to hoist ore until No. 3 shaft was completed. The new No. 3 shaft, 465 ft. deep, was completed and placed in operation in March, 1943, and after that date all ore was hoisted through it. The main haulage level was at 340 ft. in the new shaft, equivalent to an altitude of 2,960 ft. A level serving the upper workings was at 220 ft. The skip-loading station at 400 ft. was served by a 500-ton concrete storage pocket. Ore entering the pocket passed through a grizzly with steel rails spaced 12 in. apart. The shaft had two hoisting compartments, 6 ft. by 7 ft., inside the timber and a manway, 5 ft. by 7 ft. The pump station was at 440 ft. The shaft was covered by a steel headframe 125 ft. high. Two 3-ton rockover-type skips were raised and lowered by a 300-h.p., double-drum hoist. Ore was released from the pocket into a measuring chute, then into the skip through two air-operated doors. At the surface mine-run ore was dumped into a 1,000-ton storage bin.

Drives on the main haulage level were driven 8 ft. by 8 ft. in cross-section. Drives in the upper levels were 5 ft. by 7 ft. and timbered only where necessary. Draw rises and corner rises were 4 ft. by 4 ft. and untimbered. Jackhammers were used in drives and light self-rotating stopers in rises; both machines used threaded steel and jackbits. The ground was highly fractured and a 5 ft. by 7 ft. drive was broken to a depth of 4 ft. by a round of 9 to 11 holes. The round was loaded with 40 to 50 sticks of 40% dynamite.

In the haulage drives muck was loaded into 2-ton gable-bottom cars with rocker-type loaders. On the upper levels slusher hoists with scrapers were used; the muck was pulled to a rise, then loaded through chutes into cars on the haulage level. Timber was used only where necessary.

After March, 1943, all ore was hoisted in 3-ton skips through No. 3 shaft and dumped into a 1,000-ton-capacity steel bin at the headframe. The crusher at the mill was fed by a pan feeder from this bin.

Mining was divided into stope development, stoping, and transportation. The west or main ore-body was developed first. Main haulage drives were driven to this area, which was divided into panels 100 ft. wide and extending across the ore-body. Blocks with a base 100 ft. square and extending the

height of the ore-body were developed as necessary and the ore was drawn and trammed to the shaft pocket in 2-ton cars pulled by battery-type locomotives. After a block was selected for mining, two haulage drives spaced 50 ft. apart and centred with the block were driven on the haulage level, which was 30 ft. below the undercut level. Haulage drives were timbered under the block. Grizzly or control drives were not used; the draw was controlled at the chute set in the haulage drive. Draw or chute sets were spaced 25 ft. apart along the drive. Intermediate sets filled in between the combination draw and chute sets. From one corner or draw-chute set, either in the stope being developed or in an adjacent stope, a rise was driven to the corner of the block at the undercut level, then driven vertically. The rise was used for a working entrance and ore pass for boundary-slice level drives established at 30-ft. intervals.

In the second stage of development, draw rises were driven at each chute set. These rises, 4 ft. by 4 ft. without timber, were driven inclined at 50° for 14 ft. or 15 ft. then vertically for 13 ft. to the undercut level. Permanent steel arc-type chute gates were installed as the rises were completed. Corner rises were completed at all corners and boundary drives around the block at 30-ft. vertical intervals. Stoper holes, 8 ft. deep, were drilled every 3 ft. and staggered along the backs of the boundary drives. As a third stage track and pipe were removed from the boundary-slice drives and the backs were blasted down. Undercut drives, driven diagonally across the block, connected the tops of the draw rises. Finally the pillars between the undercut drives were drilled with 5-ft. and 6-ft. holes (three holes to the row and rows spaced 3 ft. along the drive) and blasted. The tops of the draw rises were belled out with three rings of holes. Blasting was begun in one corner of the stope and " bell out " in the draw rises was blasted with the undercut as it advanced across the stope.

Stopes were 100 ft. square, no pillars being left. The rock was hard and broke coarse and blocky and the coarse material frequently clogged the throat of the draw rise and made it necessary to blast the larger boulders. A bomb made by tying sticks of dynamite to the end of a 1 in. by 1 in. blasting stick was placed against the boulder and the bottom end of the blasting stick was wedged to hold the charge in place. The dynamite was fired with an electric blasting cap.

Ore was drawn from the stope through a 20-in. by 30-in. opening into 2-ton gable-bottom cars, the rate of draw being controlled by hand-operated steel arc gates. Three 1½-ton battery locomotives were used to position the cars under the loading chutes and assemble them in trains. Two 3-ton battery locomotives pulled the loaded trains 1,200 ft. to the shaft pocket, where the ore was dumped through a grizzly of steel rails spaced 12 in. apart.

Ore from the 500-ton concrete-lined pocket was drawn into a measuring cartridge, then dropped into the skip. Flow was controlled by air-operated gates. Spillage was collected in a pocket and returned to the haulage level with an auxiliary hoist.

The caving method proved successful at 200 tons to 300 tons per day; however when the capacity of the plant was expanded to 2,500 tons daily in 1943 labour was scarce as a result of World War II and development lagged. Furthermore, the average thickness and the hardness of the chalcocite ore were such that the tonnage recovered per foot of development was low. This resulted in rapid draw on the developed blocks, which increased the dilution from the oxide capping. Part of the ore-body came close to the surface and caved stopes broke through it. Some of the ore was covered with relatively thin overburden along Copper Creek.

An area was selected where the overburden was thinnest, then the overburden was stripped of waste by contract. A rise was started from the underground workings below the area and driven to the surface. After the rise reached the surface the ore at the top was blasted and bulldozed directly into the rise. On the haulage level the ore was drawn into cars and trammed to the shaft pocket. This method was more economical than block caving and was expanded until four glory holes were in operation. The block caving then gradually was discontinued. In 1941 the mine operated 336 days and yielded 88,209 tons of ore for an average of 262·5 tons per operating day.

The underground mine produced very little water—about 150 gal. per min. Before 1942 water for milling the ore was obtained from wells in the gravel of Copper Creek and from springs. After the R.F.C. approved a loan to equip the property for production at the rate of 2,500 tons per day a 10-in. pipeline was constructed to wells along Burro Creek and provision also was made to recover water from the tailings dam.

During the period before 1943 power was generated in a diesel plant at the mine. As part of the expansion programme in 1942 a powerline was constructed from Parker Dam, on the Colorado River, to the mine and after February, 1943, power was obtained from that source.

The size of the mine and the contemplated rate of production have been less than required for economical operation of a smelter on the property; however, the isolated location made a long truck haul necessary for supplies and concentrates. The long truck and rail hauls, *plus* custom-smelting charges, necessitated the elimination of all possible weight from the concentrates. These factors also prompted experimental work with a leaching process.

With the object of producing refined copper at the mine, milling tests were started. The first mill built for experimental testing was a 50-ton flotation mill. According to Young recoveries in this mill were 87·7% of the total copper and 91% of the sulphide copper, with a concentration ratio of 32·8 : 1·0 and a concentrate grade of 37·7% copper. The flotation concentrate from this test mill was treated in an experimental electrolytic plant. Concentrates were roasted in three stages at 500°, 980°, and 1,100° F. The calcine was agitated with electrolyte and the copper-bearing solution, which contained 60 g. of copper per litre, was passed through electrolytic cells, then through a trough filled with de-tinned scrap. During a nine-month run 97% of the copper was precipitated in the electrolytic cells and 3% as cement copper. Metallurgically this experimental plant indicated a successful process. However, more than 40,000 ft. of sample-hole drilling had indicated a sulphide ore-body containing 1·5% copper, which could be treated by flotation. Because of the high capital cost of a plant to roast and leach the ore and precipitate the copper by the electrolytic method, a decision was made to defer treatment of the oxide ore and mine the sulphide ore, which could be treated by the flotation process with smaller capital investment. Accordingly the 50-ton plant was enlarged to a

200-ton-per-day flotation plant in 1930. Because of the low prevailing price of copper, this plant was not operated from 1931 to 1934. Beginning in 1935 the plant operated, with minor improvements, until March, 1943, when a new concentrator with a capacity of 2,500 tons per day was completed.

During 1941 the concentrator processed 88,209 tons of ore in 336 operating days, or 265·5 tons per day. Mill recovery was 82·77%. Approximately 2,590 tons of concentrate containing 44·33% copper was recovered from ore that averaged 1·57% copper. In 1945 the new plant processed 618,711 tons of ore.

Technical Progress at a Canadian Gold Mine

Some notes on technical development at the Madsen Red Lake mine, a gold property in North-Western Ontario, are given in the *Canadian Mining Journal* for March. At this mine light-weight airleg drills are used exclusively together with collared hexagonal $\frac{7}{8}$-in. detachable tungsten carbide bits for all types of work. Reconditioned collarless rods are employed with stopers equipped with tappets. Sectional rods made up from standard drill steel coupled with C.I.R. X-L couplings are in use for holes up to 25 ft. for slashes and wide stopes. Test work has indicated the feasibility of using $\frac{3}{4}$-in. drill rods with smaller bits and powder diameters, particularly for stope work. Further experimentation is being carried out in this connexion for driving and rising applications. Rock-drill and steel costs were reduced during 1958 as a result of an increased programme of education in the care and operation of equipment. A definite increase in bit life as well as savings in time and energy resulted from using a small-size rivetting hammer to remove " broken-off " drill rods from detachable bits.

Increased footage broken per round accompanied by a reduction in cost are the direct results of reaming of cut holes to $2\frac{1}{2}$ in. in drive and rise rounds and cut-off rounds or blow-outs are uncommon.

The adoption of a special mucking train as used in Europe will take an entire round of muck from development ends thereby eliminating loss of time due to switching cars. The train will consist of ten 120-cu. ft. bottom-dump cars with a special loading car at the front end and a scraper car adjacent to the motor. An Eimco 21 Loader will muck into the front car and a 48-in. scraper pulled by a 30-h.p. two-drum scraper hoist will move the muck back along the train, progressively filling each car. Time studies indicate that a 10-ft. round in an 8 ft. by $8\frac{1}{4}$ ft. heading may be cleaned out in two hours.

Interesting features of the shaft-sinking programme now in progress to a depth of 4,000 ft. is the use of 8 in. by 12 in. reinforced-concrete dividers for additional wall support and to hold guides and pipes in the 8 ft. by $36\frac{1}{2}$ ft. opening. Costs are roughly equivalent to that of framed timber in a comparably sized shaft, while the objectives are to achieve permanency and to reduce maintenance costs and fire hazards. Walls of the shaft are supported by means of rock bolts and wire mesh.

Hoisting in the new shaft will be by two ASEA Koepe type hoists of 11-ft. diameters operating to a depth of 3,750 ft. The hoists will each have four $1\frac{1}{8}$-in. pull ropes, 6 by 27 by 33 right-lay flattened strand, of drawn electro-galvanized type. Four $1\frac{1}{8}$-in., 18 by 19 non-rotating tail ropes will be used. Two $9\frac{1}{2}$-ton capacity skips will operate in counterbalance at a maximum speed of 1,500 f.p.m. using two 500-h.p. motors. A 6 ft. by $11\frac{1}{2}$ ft. double-deck aluminium cage will operate with a counterbalance using a 500-h.p. motor. A unique feature will be the hoisting of development muck from new levels using an 80-cu. ft. skip fitted inside the cage and operated in the same manner as a bottom dump skip. This skip is mounted on a wheeled carriage and it can readily be moved in or out of the cage as required. Loading will be from loading pockets at the levels and the skip will dump automatically into a waste bin on surface. Both cage and skip hoists can be operated either manually or automatically as desired.

Cut-and-fill stoping of erratic ore occurrences has been made economically feasible by the use of hydraulic tailings fill and air-leg mounted Packsack diamond drills. These drills have become an almost indispensable mining tool for probing walls for ore limits and to locate off-shoot lenses or parallel structures. Holes to a depth of 58 ft. are readily drilled and the diamond drill is incomparably more accurate than test holing with percussion machines. Visual or " Eye-Ball " assaying of the core recovered is sufficiently accurate to determine whether the walls should be slashed or not. An improvement in grade and an increase in tonnage of ore recovered has resulted.

Roof bolts have been used successfully in stopes and other underground working places for the past four years. As a direct result stope support costs have been reduced by 13 cents per ton of ore broken and there is as well the indirect benefit of improved mucking and breaking efficiencies. In areas considered to be permanent the mine has standardized on $\frac{3}{4}$-in. High Strength bolts in 8-ft. lengths in conjunction with expansion shells. For stope back and walls $\frac{5}{8}$-in. rods 7 ft. long are in general use. During 1958 a switch to left-hand threaded bolts was inaugurated permitting the same machine to both drill the hole and to " set " the bolt by means of an adapter socket. This has resulted in considerable economy of time and a better job of rock-bolting.

The use of classified tailing fill placed hydraulically has been most satisfactory and has resulted in definite cost savings and higher stope efficiencies. It has also made possible the mining of off-shoots from the main zone and parallel zones of limited extent.

Special attention is being paid to provide adequate fresh air to all working parts of the mine. In this connexion a 150,000-c.f.m. capacity fresh air vertical axial-flow fan was installed in 1958 in casting to the mine through a 10 ft. by 10 ft. ventilation rise. The fan is centrally located and feeds air down through a system of rises, stopes, and a shaft. Sufficient air is bled to the shaft at the levels to keep it upcast to surface. In addition an 80,000-c.f.m. horizontal axial-flow fan exhausts air at the east end of the mine and a 40,000-c.f.m. axial-flow fan exhausts at the west end. Control is provided by the use of ventilation doors, brattice walls, and air locks. The system has been designed to provide ventilation to a depth of 5,000 ft. with only minor alterations.

Ore Discoveries at Mount Isa

A series of papers on Australian geology has been collected by the Australasian Institute of Mining and Metallurgy and issued as an " F. L. Stillwell Anniversary Volume." Among these papers is one by S. R. Carter, giving some " Notes on Recent Mount Isa Ore Discoveries," from which the following paragraphs have been abstracted.

In 1953 the total known length of the copper ore-bodies was 1,500 ft. Now the plan of No. 12 level and the longitudinal section through the 500 copper body show the ore extending 5,000 ft. farther south. Under the economic conditions prevailing early in 1958 the payable copper ore is not quite continuous for the total length of 6,500 ft. The ore is silicified and dolomitized shale with chalcopyrite, pyrite, pyrrhotite, and minor cobaltite.

The copper ore-bodies occur within a zone of silicified and dolomitized shale known locally as " silica-dolomite." The size of the zone of silica-dolomite as now known is more than commensurately larger than the silica-dolomite body known in 1953. The silicification and dolomitization appears to be associated with a number of more or less separate shears in the shale. About half of the shale within the zone is unaffected by shearing and the distribution of dolomite and silicification is therefore patchy. The shales within and adjacent to the zone of shearing were folded before shearing, silicification, and dolomitization, with folds of amplitudes up to 30 ft. measured normal to the bedding. The zone of shears is known to be at least 8,000 ft. long and 1,300 ft. wide at 2,000 ft. depth. This zone of shearing should not be confused with the almost parallel Mount Isa shear, which is some 1,700 ft. farther west.

There is no outcrop of copper ore at Mount Isa. The silica-dolomite zone does, however, reach the surface in a number of relatively small discontinuous outcrops—" breccia zones." Costeans put in a few hundred feet south of the " breccia zones " show no sign of the silica-dolomite (or of folding or shearing), though this zone is known to be 1,000 ft. wide less than 2,000 ft. beneath the surface. The breccia outcrops were mapped in the middle thirties, but they were not recognized as the surface expression of the silica-dolomite bodies until 20 years later. Crosscuts between the Black Star and Racecourse groups of ore-bodies have shown that the silica-dolomite between the Black Star and Racecourse is similar to the silica-dolomite containing the Black Star copper ore-bodies which lie west of the Black Star lead ore-bodies. It is now known that the silica-dolomite body west of the Black Star and the one between the Black Star and the Racecourse ore-bodies join going south to form the host for the 500 copper ore-body. The principal reason for the delay in recognizing the breccias as the outcrop of the silica-dolomite is that the Black Star silica-dolomite body does not outcrop. Its top is at 400 ft. below the surface and one or two small quartz stringers in an outcrop of a few square yards is the only surface expression of the large silica-dolomite and copper ore-body beneath.

It is now known that the " breccias " represent the weathered near-surface portions of the silica-dolomite where, to the depth of the water table (about 200 ft. and locally deeper), the dolomite has been leached out, the sulphides oxidized, and the metals removed, converting the silica-dolomite to ferruginous jaspers and kaolinized shales. The primary quartz fillings of shears and fractures—uncommon outside the silica-dolomite shear zones—are retained, and collapse of ground weakened by leaching has accentuated the breccia condition which is only locally and weakly developed in the unweathered silica-dolomite. Core drilling below the level of oxidation through the silica-dolomite zone between the Black Star and Racecourse ore-bodies has proved that chalcopyrite equivalent to about 0·5% Cu occurs throughout the zone over a length of at least 3,000 ft., a width of up to 350 ft., and to a depth of at least 600 ft. Limited core drilling and underground development in the silica-dolomite zone to the south outside the limits of payable copper ore-bodies confirms that the silica-dolomite shear zones everywhere contain at least a sprinkling of chalcopyrite. Therefore it can be assumed that the silica-dolomite bodies that reach the surface as " breccias " also originally contained chalcopyrite and other associated sulphides in the 200 ft. or more between the water table and the surface. A cross section (5000N) shows the Black Rock secondary copper ore-body in section. It is thought that this copper ore-body owes its origin to :—

(*a*) Decomposition of chalcopyrite down to the water table ;

(*b*) transportation of the copper in ground waters, probably as copper sulphate to nearby calcareous shales, and

(*c*) deposition of the copper as carbonates and silicate by successive permeations of copper-bearing solutions whilst the water table was gradually falling.

It is also thought that the chalcocite, native copper, and cuprite could have formed under reducing conditions below the water table by reaction between descending copper solutions and primary sulphides.

These secondary copper minerals form a substantial ore-body containing 5% Cu and 63% SiO_2, which is being mined by open-cutting. Neither the lateral nor the lower limits of the ore-body have yet been reached by exploration. In this deposit oxidation has reached at least 500 ft. depth, which is about 300 ft. deeper than is usual elsewhere at Mount Isa.

The shales in which the secondary copper ore-body occurs do not contain chalcopyrite and there is no evidence that it ever occurred in the shales. These shales do, however, contain the fine-grained pyrite which is common throughout the mine area. In the unweathered zone the pyrite is found interbedded with the shale ; in the oxidized zone the pyrite " beds " are represented by ferruginous bands in the shale.

The 2400N cross-section shows greenstone lying beneath the silica-dolomite zone. Some 800 ft. farther south another greenstone intersection was obtained in a core hole at a depth of about 3,000 ft. Greenstone is also shown on cross-section 7000N and a lenticular body of greenstone is seen on surface in the hanging wall of the Black Star ore-bodies with a length of 3,200 ft. and width of up to 1,000 ft. Limited exploration indicates that this greenstone body is roughly the same dimensions at 1,500 ft. below the surface. The greenstone may possibly be found also in deeper unexplored ground.

The mineralization in the silver-lead-zinc ore-bodies has been found to continue strongly down rake. This is shown on longitudinal sections through the Black Star and Racecourse ore-bodies. The extensions of the Black Star ore-bodies are somewhat lower in grade than the upper portions of the Black Star, but the extensions of the Race-course bodies are up to average grade of ore mined in the past.

Trade Paragraphs

Hackbridge and Hewittic Electric Co., Ltd., of Walton-on-Thames, Surrey, have recently issued four new publications. These are devoted to cooled-cathode rectifiers, germanium and silicon rectifiers, oil-immersed rectifier equipment (selenium, germanium, and silicon), and metal rectifier equipments.

Hunting Aerosurveys, Ltd., of 6, Elstree Way, Boreham Wood, Herts., announce that they have recently set up a photographic advisory service designed to assist those interested in the application of aerial photography to exploration and development programmes in all parts of the world.

R. F. Fraser-Smith, of 69, Kings Cross Road, London, W.C. 1, announce the production of a new portable magnetic crack detector. The apparatus weighs 45 lb. and gives an output of 750 amps. It is fitted with a change-over switch allowing operation on 100/120 or 200/250 volts a.c. single-phase supply. A leaflet issued by the makers explains the principle of flaw detection and gives suggestions for operating the instrument

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, have published a booklet entitled " Friction Charts for Air Flow in Straight Ducts and Pipes." This was originally produced after a considerable amount of investigation for use within their own organization. When it became apparent that it would be useful to many other engineers it was decided to reproduce it for wider circulation.

Turner Brothers Asbestos Co., Ltd., of Rochdale, Lancs., have announced an addition to their range of woven asbestos cloths, among which several qualities are now available having a coating of bright and highly-reflective aluminium. This innovation is evoking a good deal of interest in industries concerned with thermal insulation problems of diverse kinds. These fabrics are also being adopted for fire-fighting and other protective clothing applications.

Lockheed Precision Products, Ltd., of Shaw Road, Speke, Liverpool, from their Industrial Hydraulics Division have issued three leaflets describing new additions to their range. These are a hydraulic pump (7-cylinder radial piston type) for pressures up to 5,000 p.s.i., a solenoid operated 4-way valve for flows up to 20 g.p.m. and pressures to 3,000 p.s.i., and semi-rotary slaves, which are a range of rotary actuators giving at 1,000 p.s.i. fluid pressure torques of 1,500 lb./in. to 500,000 lb./in. and movement up to 300° or, with double vanes, approximately twice these torque figures and 120° angular movement.

LeTourneau-Westinghouse Co., of Peoria, Illinois, announce several new features in their motor grader line. Among these are new circle size, more visibility, easy moldboard tilt adjustment, enclosed ball-socket lift link caps, and a new 6-cylinder engine. The new big circle, which provides more blade stability, is now 63 in. (9 in. more than formerly) and this permits the operator to do a more efficient job of finish grading. A new moldboard tilt adjustment is a time saver. Only one nut need be loosened on each circle leg to make desired adjustment. The new engine is the 4-cycle Cummins C-160-BI. These power plants range from 115 h.p. to 145 h.p.

Blagden-Durham, Ltd., of Framwellgate Works, Durham, have recently added two new sump pumps, the AP.1 and AP.2, to their range. They point out that they are the designers and originators of the manually-portable rotary-drill-driven mining pump which has been proved underground in this country and overseas. The new pumps are described as the smallest air-power-operated units of their kind in existence. The AP.2 is the subject of an illustrated descriptive leaflet which shows that it is intended for handling water containing solid matter and fluids that are not highly corrosive at the rate of 10,800 gal. per hr. at 10-ft. head or 3,000 gal. at 70 ft. for an air consumption of 70–80 c.f.m. at 80 p.s.i.

Pyrene Co., Ltd., of 9, Grosvenor Gardens, London, S.W. 1, has formed a subsidiary company—Pyrene-Panorama, Ltd.— which will take over the existing business of Panorama Equipment, Ltd., and its associated companies, makers of safety equipment which includes miners' helmets. The new company will operate from Reynard Works, Windmill Road, Brentford, Middx. The statement continues: " This acquisition is in furtherance of the established practice of the Pyrene Company to continue to extend its field of activity in the realm of safety engineering. It has already taken considerable part in this direction and in the past has included dust allaying apparatus for use in mines and dust respirators in the range of its safety products."

Moxey, Ltd., of 13, Augustus Road, Birmingham, have been awarded a contract by the South Durham Steel and Iron Co., Ltd., for the manufacture and installation of ore-handling and grading plant at their West Hartlepool South works. The plant will handle graded and ungraded ore at the rate of 700 tons per hour from railway wagon tippler to a distribution house whence the ore may be conveyed to the screen house, to the 1,000-ft. long stockyard by boomstacker, or direct to blast-furnace bunkers. Also handled by the plant will be limestone, coke, and sinter. The type of plant they manufacture is indicated in a 32-page illustrated general catalogue, which shows this to include conveyors and elevators of several types, vibrating screens, belt-conveyor idlers, wagon tipplers, and skip hoists.

Frederick Parker, Ltd., of Catherine Street, Leicester, have lately added a new model to their range of crushing rolls. This is now the largest in the series—30 in. by 24 in.—for outputs of 32 tons to 75 tons an hour and a feature of the machine is hand-operated hydraulic pump for spring tension adjustment. It is designed for producing stone crushed to *minus* $\frac{3}{8}$ in. It has a fabricated steel frame and hard wearing rolls of manganese steel and is internally machined and taper mounted for quick and accurate assembly. Roll settings are obtained by inserting or removing small shims. The drive is by oil-bath lubricated gear and pinion from counter-shaft to fixed shaft and then to floating shaft by

finger gears. This ensures positive drive at all settings, reduces wear, and gives smooth operation even when the rolls are temporarily misaligned by uneven feed through the rolls.

Denver Equipment Co., of Denver, Colorado, London office: 15–17, Christopher Street, Finsbury Square, E.C. 2, issue particulars of the Denver Dowsett valve for the automatic density discharge control of jig hutch products and like applications. It consists of a housing and a diaphragm-operated valve, the diaphragm keeping the valve closed until enough solids are accumulated to overcome the differential in pressure, when the valve opens and discharges at 70% to 80% solids. The solids having been discharged, the pressure of water against the diaphragm again closes the valve. It can thus be used as an automatic sand bleed valve on all machinery where sand and dense pulp must be discharged continuously or intermittently from mineral or plunger jigs; also thickener, settling cone, and hydroclassifier underflow can be automatically controlled and low-density underflows eliminated.

E. Boydell and Co., Ltd., of Old Trafford, Manchester, have added a more powerful version of the Muir-Hill 3-cu. yd. dumper to their range. The machine is powered by a Fordson "Power Major" 3·61 litre 4-cylinder diesel engine which develops 52 b.h.p. at 1,600 r.p.m. and has an increased maximum torque of 171 lb./ft. at 1,200 r.p.m. Power is transmitted through an hydraulically-actuated dry-plate clutch to a constant-mesh gearbox providing six forward speeds of 2·07, 2·92, 3·73, 5·25, 7·32, and 13·16 m.p.h. and two reverse speeds of 2·80 and 5·03 m.p.h. Hydraulic transmission incorporating torque converter and epicyclic gearbox is an optional extra. A range of gravity and hydraulic tipping bodies suitable for handling a variety of materials is available together with a selection of tyres for differing ground conditions. The successful Muir-Hill two-way drive whereby the seat and steering column can be rotated to face the direction of travel is standard.

Ericsson Telephones, Ltd., of High Church Street, New Basford, Nottingham, are revising their catalogue of electronic instruments so that users may have a minimum of trouble and delay in finding that in which they are particularly interested. As an example, in the section dealing with nucleonic apparatus is a sheet dealing with bore-hole logging equipment. In a general note in this they state that when prospecting for radioactive minerals the bore-hole logging equipment Type 1417A developed by Hendrey Relays, Ltd., in conjunction with the A.E.R.E., Harwell, can be used. It uses an ETL field ratemeter Type 1368A to provide audible or visual indication of the level of radioactivity in ore. The equipment, which is fully portable, is designed for the detection, estimation, and control of radioactive minerals during mining and can be used for measuring lower levels of radioactivity at any depths down to 1,100 ft. It can be operated at ground level or underground in mines, as desired, to provide a permanent record of the gamma flux profile in bore-holes having a diameter of not less than 1 in. (2·54 cm.).

General Electric Co., Ltd., of Magnet House, Kingsway, W.C. 2, state that the value of recent orders for winders placed by the National Coal Board now totals nearly £400,000. They include two winders for the Birch Coppice Colliery, rated at 400 h.p. and 1,490 h.p. The larger winder is of particular interest in that speed control is effected by a grid-controlled mercury-arc rectifier. The other three winders are a 1,450-h.p. machine for Western Colliery; one of 1,900 h.p. for Caerau Colliery, and another of 1,100 h.p. for Cortonwood, for which a 2,000-h.p. winder is already on order. With the exception of the 1,490-h.p. rectifier winder all the equipments are a.c. and have compensated dynamic braking. Mechanical parts of the Cortonwood winder are being supplied by Fullerton, Hodgart, and Barclay, Ltd., and of the other four winders by Robey and Co., Ltd. These orders follow closely on contracts recently announced for five winders valued at over £600,000, for which the G.E.C. is supplying both the electrical and mechanical parts. The total value of winder orders placed by the National Coal Board with the company within the past 12 months is thus brought to over £1,000,000.

G. E. Simm (Engineering), Ltd., of 27, Broomgrove Road, Sheffield, recently demonstrated in London an improved type of stainless-steel clamping strip which has been well-known in the U.S.A. for some time and is now to be marketed in this country. It is produced by the Band-It Company, of Denver, Colorado. The system consists of stainless steel band and buckles and a special hand tool for applying the clamps. The band—which is supplied in widths of ⅜ in., ½ in., ⅝ in., and ¾ in.—can be wrapped round any object without the need to disconnect it. The clamps can be applied by one man in a few seconds in diameters of ½ in. to 30 ft. Even larger sizes can be clamped by joining lengths of band together with buckles. Application is simple, the band—packed in 100-ft. lengths in cardboard dispensers—being passed round the job and the ends slipped through a buckle. Tension is applied by the tool which tightens and fixes the band in the buckle and then cuts it. For close quarters work there is a special type of buckle and simple tool. The band—which has rounded edges to prevent damage to hoses or plastic pipes—and the buckles are also available in special steels or non-ferrous materials for certain chemical applications.

Johnson, Matthey and Co., Ltd., of 73–83, Hatton Garden, London, E.C. 1, have acquired an interest in the Metalli Preziosi S.p.A., of Milan. This Italian precious-metal refining and manufacturing company has a history of over 100 years and is the largest enterprise of its kind in that country. Considerable expansion of its refineries at Paderno Dugnano are in hand. The statement points out that Johnson, Matthey and Co. have been working in collaboration with Metalli Preziosi for a number of years and some 10 years ago entered into arrangements with this company with regard to their general representation in Italy. The closer association now announced is thus a logical development of previous understandings which have proved mutually advantageous. It provides for technical as well as commercial integration and gives the Italian company access to the resources of the research organization of the Johnson, Matthey group.

In a new leaflet they give particulars of Mallory No-Chat vibration damping tool shank material, which has been developed after careful consideration of the characteristics that are necessary to minimize tool chatter without increasing the size of tool supports. The brazing of cemented carbide tool tips to the material presents few problems, it is stated, because the coefficient of thermal expansion of the materials are very similar.

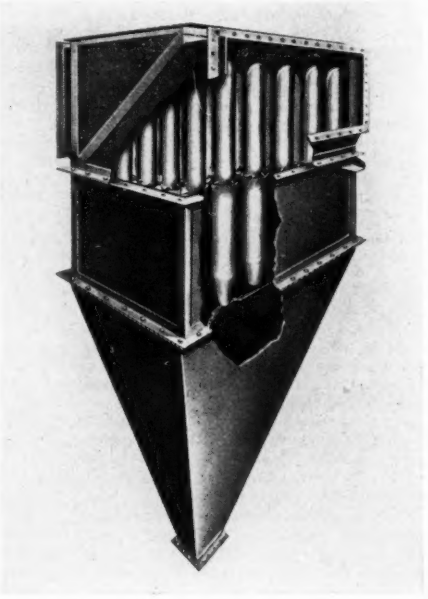
Aero Maintenance Equipment, Ltd., of 47, Victoria Street, London, S.W. 1, sole concessionaires in this country of the Bennes Marrel appliances generally manufactured in St. Etienne, France, are now producing these units at a factory in Cumberland. The Marrel multi-container unit, it will be recalled, was described in the MAGAZINE for July last, but last month we were afforded the opportunity of seeing the Multi-Crane unit at work on a site in Hertfordshire. This device, mounted on a 20-ton gross chassis, transforms a truck into a self-contained unit combining the advantages of a crane and a tip truck. Besides the two lifting arms the " multi-buckets " crane has a third ram which actuates the cable of a lifting boom. Combination of the forward or backward motion of arms, with the upwards or downwards action of the lifting boom, actuated by a ram, allows great precision in lowering the load at the exact point chosen, whatever the bulk or shape of the load may be. The unit has been widely used for transporting a great variety of loads, including crushed rock or excavated overburden. It comprises a heavy-duty all-steel platform of welded construction mounted directly on to the chassis frame. Lifting arms of heavy steel plate, welded in box section form are operated by two double-acting hydraulic rams driven from the engine gearbox power take-off and operated from the vehicle cab. Lifting chains of electrically-welded chrome-molybdenum alloy steel are fitted complete with a safety self-locking assembly, while dumping hooks of high-tensile steel forging are operated through a mechanical linkage to the cab, giving a tipping action of 90°.

Head, Wrightson and Co., Ltd., of 20, Buckingham Gate, London, S.W. 1, announce that arrangements have been made whereby they become licensees for the Stripa dense-medium process in the United Kingdom and the Commonwealth (excluding Canada). The exploitation of the process will be in the hands of their subsidiary, Head Wrightson Colliery Engineering, Ltd., who will use it in conjunction with the Stamicarbon (D.S.M.) processes which have already been incorporated in many successful plants. It may be recalled that the process was developed at the Stripa mine controlled by Staellberge Grufveaktiebolag, where high-grade iron ore concentrates are produced. The initial local success of the process at Stripa mine encouraged other mines in central Sweden to adopt it and seven plants have been installed in recent years.

In the process a convenient separating medium—for example, a suspension of magnetite or shale—is fed to a shallow reciprocating trough and the mineral to be treated is added a short distance from the medium feed point. The medium is concentrated to some extent in the trough and conditions are set up permitting quick and accurate separation of a floating fraction and a sinking fraction which are discharged separately at the end of the trough, the cut between them being made by an adjustable splitter plate. The medium solids used can be relatively course and medium recovery systems are therefore very simple

In a separate notice they state that during the early part of the second world war Britain supplied much of the equipment for the Morgul copper mines in Eastern Turkey. For this project the company were responsible for providing classifying, grinding, and drying equipment in addition to a number of copper converters. Financed as part of the American ICA dollar arrangements large quantities of spares have been dispatched to Turkey and recently they have received orders for equipment amounting to 125,000 U.S. dollars from the Turkish Government Agency ETI Bank.

Steels Engineering Installations, Ltd., of Crown Works, Sunderland, are now making under licence the SPA dust collector—one of the multi-cellular groups of dry centrifugals which depends on a unique principle of selective particle acceleration. The following are given as the main advantages :—Collection is extended to the smaller particle sizes, collector wear is eliminated, and despite the high collection performance the pressure drop and hence power consumption is low. The collector, as may be seen from the illustration, comprises a number of



standard elements housed within a fabricated steel body with dust-collecting hopper, the number being varied to meet the volume requirements of each application. There is no secondary system to effect final separation of the finer particles and requiring a secondary booster fan, separation of the entrained particle being carried out in one operation within the collector elements.

Each element comprises an inner and outer member assembled co-axially. The outer member is formed in two parts : an operating zone and a cylindrical collector tube, the two being welded together. The operating zone forms a funnel with rapidly decreasing cross-sectional area, the upper end being hexagonal in section and the lower end circular to match the cylindrical collector tube. The inner member comprises a straight length of mild-steel tubing, flanged at the top, passing centrally through the operating zone, co-axial with the collector tube and extending a little below the bottom of the operating zone. Within the annular space formed between the operating zone wall and the inner member are placed six guide vanes, these

vanes being welded to the inside of the operating zone only.

Dust-laden air enters the element over its hexagonal face at low velocity. The guide vanes deflect it into a helical path and as it passes through the nozzle it is rapidly accelerated along this helical path by virtue of the decreasing cross-sectional area. The air emerges from the operating zone at a velocity of six times that at which it entered. It flows approximately two-thirds of the way down the collector tube in this helical path before reversing up the central core of the vortex to leave the element through the inner member. The separated dust flows down the walls of the open-ended collector tube to be deposited in the hopper beneath. A straightening vane, placed inside the inner member, recovers some of the swirl energy and reduces frictional losses by restoring straight flow.

Caterpillar Tractor Co., Ltd., of P.O. Box No. 162, Glasgow, have lately added to their range of earth-moving equipment the No. 619 wheel tractor-No. 442 scraper combination, which in the illustration is shown on test at the U.S. company's proving grounds at Phoenix Arizona, where the earth-mover is being pushed by a Cat D.8 Series 8 tractor. The new No. 619 is powered by a 225-h.p. turbo-charged diesel engine, especially matched in the power output to the demands of the 14-cu. yd. (struck) capacity of the No. 442 Series B scraper. Top speed is 30·2 m.p.h. The high travel speed has been made possible as a result of research into tractor-scraper balance. On accessibility the makers state that the transmission, differential, and cable control can be removed as a single unit by one man in approximately 30 min., the cable control alone being removable in 10 min. Also the dash is hinged so that it can be swung to one side allowing ready access to the starting engine, air-compressor, and hydraulic pump with a minimum of time and effort and the entire left side of the engine can be exposed without dismantling any major component connected with the dash. Tyre replacement costs are minimized by the use of 26·5 by 25 26-ply tubeless tyres on both tractor and scraper. These tyres are matched in carrying capacity to the earthmover's loaded weight. Another feature is the hydraulic steering system which incorporates a built-in safety device, in that a greater amount of turning power is provided when coming out of a turn than when going into a turn. The No. 442 Series B scraper has a capacity of 18 cu. yd. (heaped) and is cable operated, with positive-controlled "dozer" type ejection apron opening of 5 ft. 4 in., adjustable scraper axles (to level the bowl), and wide section, tubeless tyres. Air-operated Syncro-Safe brakes are standard.

A more recent announcement refers to a new 360-h.p. Model B Tournapull for which a new transmission is also offered. The new engine is a GM turbo-charged six-cylinder two-cycle diesel (6-110T) and is available in combination with either the special Allison torque-converter transmission or the newly-offered step-gear transmission. The Allison transmission permits altering gear ratios to provide a better selection of speeds. The step-gear transmission is a smoother and easier shifting unit made possible by the elimination of the shifting lever on the auxiliary gearbox. Thus only one lever is used by the operator since the gearbox is air actuated. The B Fullpak scraper remains at its struck capacity of 21 cu. yd. and 28 cu. yd. heaped. Standard equipment on the scraper is a quick drop mechanism on the bowl lift. It is readily interchangeable with other trailing units designed for use behind the prime mover. In addition to the scraper there are currently available a 35-ton rear dump and a 30-ton crane in the "B" size units.

Engineering Marine Welding and Nuclear Energy Exhibition[1]

British Ropes, Ltd., of Doncaster, used their stand for a series of displays showing how ropes should be handled to ensure safety and good service. One, for example, demonstrated graphically how the load in a two-legged sling is severely increased as the angle between the sling legs becomes greater, while another pointed to correct storage, uncoiling and unreeling, cleaning, and dealing with broken wire.

British Steam Specialties, Ltd., of Fleet Street, Leicester, drew attention to Mucon valves, made by Mucon Engineering Co., Ltd., of South Ruislip, Middx. The valve is designed to control the flow of substances in bulk storage and is suitable for any free-flowing solid. It can act as a regulator valve, an isolation valve, and for other purposes, its chief feature being an infinitely variable central orifice obtained from the fabric diaphragm. The valve may be used in conditions of vacuum (max. 20 in. H.G.). It will handle, with suitable diaphagm materials, slurries, the flow of air, the flow of gases, and, by special application, will handle water under pressure. Standard valves made in gunmetal or cast aluminium alloy are fitted with the Mucon flexible diaphragm which forms a concentric aperture which may be infinitely varied from fully closed to wide open by the movement of a lever ratchet handle through an arc of 180°. The fabric diaphragm will withstand many months of hard

[1] Continued from the April issue.

wear and can be cheaply replaced by unskilled labour in a few minutes. It is suitable for the flow control of all free-flowing solids—such as, crystalline and powdered chemicals, cement, and sand.

G. A. Harvey and Co. (London), Ltd., of Greenwich Metal Works, London, S.E. 7, had as principal exhibit on their stand a wire-weaving loom in operation, one of the many types of loom installed in their works. Woven-wire screens and perforated metal products were also shown, while their associated company Nuclear Engineering, Ltd., exhibited gamma radiographic equipment for the non-destructive testing of metals, alloys, plastics, and assemblies.

James Howden and Co., Ltd., of 195, Scotland Street, Glasgow, called attention to the high-speed positive rotary compressor, which was described in the MAGAZINE in November last. It may be recalled that the compressor is comparatively simple, consisting of two rotors, a casing, four journal bearings and thrust bearings and timing gears, the rotors being of helical form. As they rotate air is drawn through the inlet port to fill the interlobe space. The air is then trapped and compressed with a progressive reduction in the volume space until released into the discharge port.

Megator Pumps and Compressors, Ltd., of 43, Berkeley Square, London, W. 1, in addition to a range of industrial pumps were showing the new Dolphin suction strainer which was described in the MAGAZINE for March.

North British Rubber Co., Ltd., of Castle Mills, Edinburgh, included in their display examples of their rock-drill hose as well as large oil hoses for dock and barge loading. Attention was also drawn to power-grip timing belts for making positive engagement with exactly grooved pulleys.

Russell Constructions, Ltd., of 8–9, Adam Street, London, W.C. 2, had on their stand examples of their special types of sieving and straining machines—namely, the Invicta screen for processing powders up to 10 tons per hour, the Cascade machine for sieving and grading at a very high rate of throughput, the fluid energy mill for reducing to micron sizes materials in a wide range of hardness, and their high-speed strainer.

Teddington Industrial Equipment, Ltd., of Sunbury-on-Thames, Middx., drew attention to their protection equipment for all types of compressors on which a note appeared in these paragraphs in the February issue. It has been developed in collaboration with the N.C.B. and is designed to give comprehensive protection against all operating hazards.

Twiflex Couplings, Ltd., of The Green, Twickenham, Middx., were showing for the first time their industrial disc brake incorporating Dunlop calliper units, among suggested applications of which are in winch and draw works operations in mining and in rotary drilling. Also shown on their stand were examples of their articulated and Flexilink couplings. A particular application to which attention was drawn is for crushing machinery drives, a 1,000-h.p. unit on a tube-mill at an Orange Free State gold mine being one of the examples mentioned.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, showed a short length of a rope-belt conveyor structure produced by their associated company Distington Engineering Co., Ltd., of which some further particulars will be given in a subsequent issue.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

21,702 of 1954 (811,171). V. J. LENGER. Electro-precipitator.

10,143 of 1956 (811,862). NEW JERSEY ZINC CO. Electrolytic production of titanium.

18,808 of 1956 (812,178). G. S. DIAMOND. Process for treating ores.

21,971 of 1956 (811,378). PERMUTIT CO., LTD. Recovery of gold from cyanide solutions.

24,947 of 1956 (812,188). STAMICARBON N.V. Wet screening of solid particles.

28,831 of 1956 (812,199). METALLGESELLSCHAFT A.-G. Roasting sulphidic materials in multi-hearth furnaces.

36,890 of 1956 (811,890). UNITED STATES ATOMIC ENERGY COMMISSION. Uranium recovery from ores.

26,851 of 1957 (811,490). JOY-SULLIVAN, LTD., C. F. BALL, and R. CAMERON. Mineral mining and loading machine.

40,480 of 1957 (812,260). METALLGESELLSCHAFT A.-G. Grate bars for sintering apparatus.

NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Mining Subsidence : A Report Prepared by a Committee of the Institution of Civil Engineers. Paper covers, 51 pages, illustrated. Price 10s. London : The Institution of Civil Engineers.

Friction Charts for Air Flow in Straight Ducts and Pipes. By R. H. YOUNG and J. M. GASIOREK. Paper board, 7 pages, with 7 charts. Price 7s. 6d. London : Sturtevant Engineering Co., Ltd.

Mining in Southern Rhodesia : Annual Reports of the Southern Rhodesia Government for 1957. Paper covers, 48 pages, illustrated. Price 10s. 6d. Causeway, Southern Rhodesia : Director of Mines.

Nyasaland Protectorate : The Geology of the Middle Shire Area. Geological Survey Department Bulletin No. 10. By S. W. MOREL. Paper boards, 66 pages, illustrated, with maps. Price 10s. 6d. Zomba, Nyasaland : Geological Survey.

Australasian Institute of Mining and Metallurgy : F. L. Stilwell Anniversary Volume, Dec., 1958, Contributions to Geology. Paper covers, 302 pages, illustrated. Melbourne : Australasian Institute of Mining and Metallurgy.

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Uganda Protectorate : Geological Survey Department Report, 1958. Paper covers, 18 pages. Price Shs. 2/–. Entebbe : Geological Survey.

India : *Records of the Geological Survey*. Vol. 79. Part 1—Paper covers, 385 pages. General Reports for 1940, 1941, and 1942. Price 13s. Part 2—Paper covers, pp. 387–872. General Reports for 1943, 1944, 1945, and 1946. Price 14s. 6d. Calcutta : Government of India Press.

Ministry of Power : Reports of H.M. Inspectors of Mines and Quarries, 1958. (1) Northumberland and Cumberland Division. By H. F. WILSON. (2) North-Eastern Division. By H. J. PERRINS. (3) North-Western Division. By R. H. CLOUGH. London : H.M. Stationery Office.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

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***Handling, Ore :** *Facilities, Virginia.* Ore Handling at a Virginia Port. J. GRINDROD, THE MINING MAGAZINE, May, 1959.

Production, Canada : *Copper, Newfoundland.* Tilt Cove Copper Operation of the Maritimes Mining Corporation, Ltd. H. G. DONOGHUE and others, *Canad. Min. Metall. Bull.*, Mar., 1959.

Production, Russia : *Coal, Study.* Some Aspects of the Coal Industry of the U.S.S.R. G. MARKON, G. D. DRECHSLER, *Inform. Circ. U.S. Bur. Min.* 7876.

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Production, United States : *Mercury, Nevada.* Cordero—Nevada's Largest Hg Mine. J. E. GILBERT, V. P. HAAS, *Engg. Min. J.*, Mar., 1959.

Resources, Canada : *Mineral, Northern.* Development of Northern Mineral Resources. F. R. JOUBIN, *Western Miner*, Feb.–Mar., 1959.

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Economic, United States : *Survey, Alaska.* Geology of Little Sitkin Island, Alaska. G. L. SNYDER, *U.S. Geol. Surv. Bull.* 1028–H.

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